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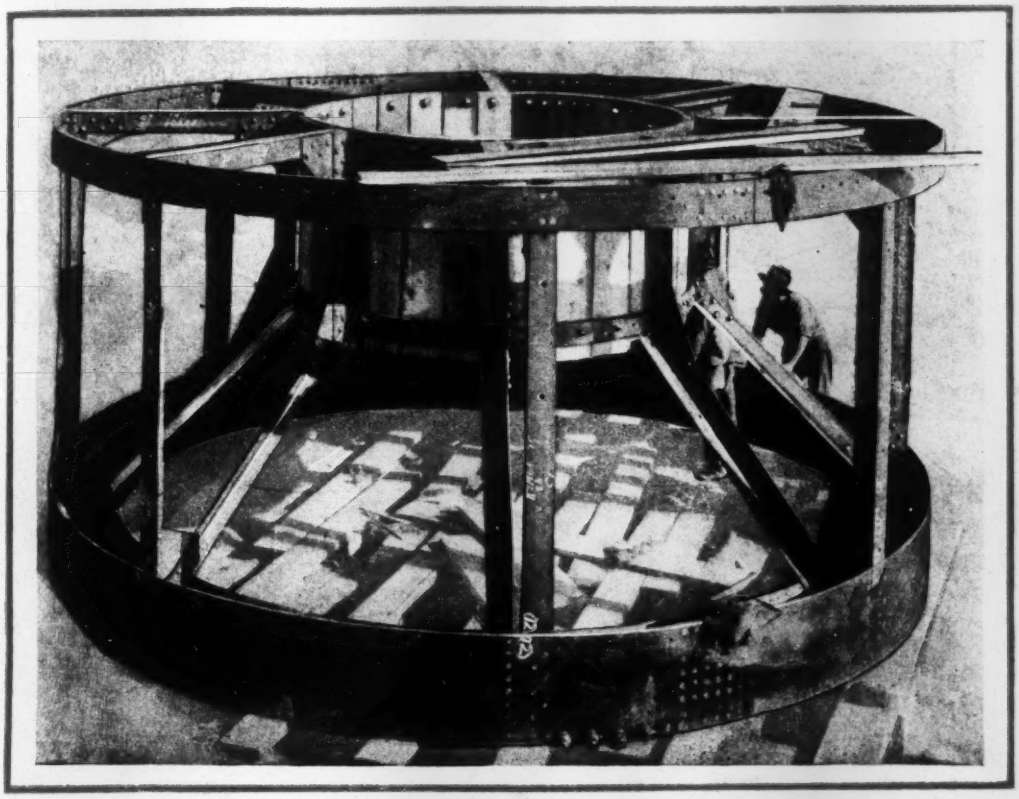

Cutting-Edge Framing for one of the Bismarck-Mandan Bridge Caissons

Foundation Work and Truss Design for the Bismarck-Mandan Bridge—*By C. A. P. Turner.*

Some Uses the Government Has Made of Aerial Photography in Map Making—*By Glenn S. Smith, U. S. Coast and Geodetic Survey.*

Practice of a Large Contracting Company in Cold Weather Concreting—*Methods and Equipment.*

Reasons for Design Features and Some Special Features of Construction in the Concrete Bridge Across the Chemung River at Corning, N.Y.

Monthly Material Prices—
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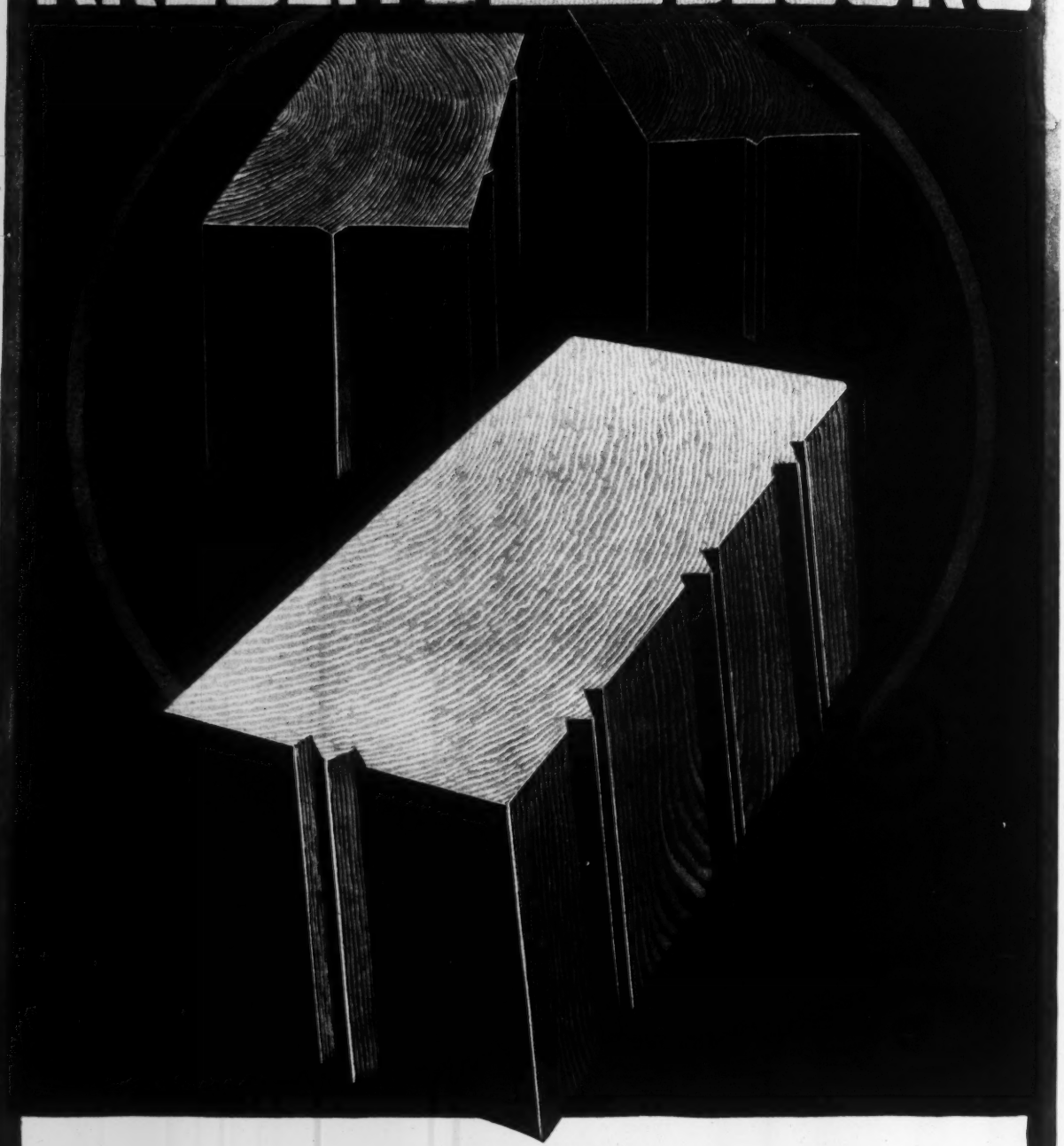

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

Volume 88 — NEW YORK, FEBRUARY 2, 1922 — Number 5

Sound Engineering

IF LAST week's editorial comment on the failure of the Palm Beach bridge has led any one into a too pessimistic view of current concrete bridge engineering, the article on the Chemung River bridge in this issue is offered as an antidote. This bridge is not especially large or complicated and its design and construction offered no extraordinary problems, but those responsible for it showed the soundest engineering and constructing sense in its study and execution. There was a most careful balancing of alternatives in design and a definite plan and purpose in construction operations, which plan was properly supervised by the engineer as the one finally responsible to the owner. The bridge exemplifies the best sort of technical precision and of professional obligation.

House Shortage and Death Rates

OUR HOUSING SHORTAGE is doubtless a menace to health, as was urged at the American Society of Civil Engineers meeting reported in our news section of Jan. 12, but the record-breaking low general death rates for 1921 in our three largest cities indicate nothing of the kind. New York came first with a tentative figure of 11.17 per 1,000. Chicago plays safe by reporting an even "eleven" and claiming that it heads the list of large cities. Philadelphia is satisfied to characterize its 1921 death rate of 12.55 as the "lowest in the history of the city." These are records to be proud of, housing shortage or not. They do not prove that the housing shortage is not a menace to health. The decline in the general death rate, despite the housing shortage, may be due to a continuation of declines in other causes that more than offset the evil effects of the housing shortage; and it may be that the shortage will suddenly cause an excess of deaths through outbreaks of communicable disease. Study of the details of the 1921 deaths by causes may disclose what the total deaths fail to show, but it seems more likely that our health bookkeeping on the one hand and our meager housing data on the other are utterly inadequate to measure the housing shortage menace to public health in terms of vital statistics.

Spring and Fall Meetings

THERE should be a favorable reception of the proposal of the Board of Direction of the American Society of Civil Engineers to hold spring and fall meetings of two days each in different parts of the country. Under this plan the society would be taken to the members three times a year instead of once. There should, as a result, be a greater interest and loyalty. One of the handicaps that a national society must endeavor to overcome is its detachment from its members. Two additional large meetings will help to overcome the difficulty. The places selected for the first experiments—Dayton, in the spring, and San Francisco, in the fall—are excellent for the purpose. Both are now the centers of much engineering interest. The practice of holding large spring and fall meetings has been tried by other national engineering societies with success, and there is no reason why it should not be equally satisfactory for the civil engineers. It will be recalled that one such interim meeting was held some years ago—at New Orleans—and was successful. The new plan aims to make these interim meetings — if well received — a regular feature of the society's activities.

Activity on Highway Standards

CRITICISM of contracting for its failure to make progress in establishing standard practices in constructing paved roads, emphasizes the equal culpability of engineering as disclosed by the committee on standards of the American Association of State Highway Officials. Only two states, it appears, have attempted to develop a "rational design" for road foundations or for monolithic road slabs. Not more than six states have given the problem serious thought. Hardly two states, it is reported, widen curves the same amount or use the same methods of widening. Such more complicated procedure as superelevation of curves or of grade compensation for curvature are utterly without uniformity in practice. There is not general agreement even on elemental factors like width and thickness, or on amount of crown or permissible grades for various surfaces. In brief, there are no standard practices in road engineering as there are none in road contracting, and road building is the greatest task of engineering construction which the United States has ever undertaken. These facts carry no tribute to either road engineers or road contractors and it is high time that the work toward standardization, ordered by the American Association of State Highway Officials in convention last month and by the Associated General Contractors in convention two weeks ago, was undertaken. Neither association has an interest of greater importance than road construction nor committees which should be driven harder in their tasks for 1922 than the Methods Committee of the general contractors and the Standards Committee of the state highway officials.

Better Convention Facilities Needed

IT IS unfortunate that the facilities offered for presenting the papers and discussions forming the technical program of the Chicago convention of the American Road Builders' Association last month were of a type which would have been a reflection on less competent men. The high character of the papers and the well balanced selection of subjects deserved a far better setting than was accorded by the auditorium in the Coliseum annex. It is not so much to the point that the hall was a dreary, ill-lighted, depressing place, for engineers are not fussy individuals and do not demand a Louis XV salon for their deliberations. They do ask, however, for an opportunity of hearing what is being said at their gatherings, particularly when the talk is

very much to the point. This was rendered impossible, most of the time, by an almost continuous rumbling of machinery in operation on the floor below. Speakers had a hard time competing with the machine-gun-like vibrations of screening devices, the grinding of rotating concrete mixers, and the clanking of dump buckets. It should be well known by this time that engineers like to "say it with diagrams." Any attendant at engineering conventions knows that fully half of the papers are generally accompanied by charts and photographs. At Chicago, however, no adequate provision for operating a stereopticon machine in the auditorium had been made, and it was necessary, in several cases, to delay the proceedings and scurry about for a man who could show the illustrations which formed an essential part of certain addresses. For a time it looked as if an important contribution on the research work of the U. S. Bureau of Public Roads, dependent in large measure upon lantern slides, was to end in a fiasco due to the lack of a stereopticon operator and a failure of electric current. It is doubtful whether any convention or road builders has listened to a better program of engineering subjects offered under such miserable conditions. The technical food was excellent, but the service was bad.

Road Building Costs

IN A falling market there is always a tendency to postpone purchases with the hope of getting in, not at a reasonably low level, but at the bottom. Prospective buyers often fail to recognize the valleys in price curves, and, by holding off too long, are forced to buy after the turn.

In some localities state highway officials have been holding back construction in the belief that lower prices could be secured by waiting. This subject was much discussed at last month's convention of the American Road Builders' Association and it is worth while repeating the advice of Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads, to the effect that, with the considerable cut in labor costs during recent months, highway authorities need not hesitate, on account of costs, to let contracts for grading, excavation, and similar work. On such work labor forms the outstanding element of cost. This view was generally concurred in by the convention's delegates, but it was emphasized that reductions in labor costs had been much greater in rural work than within city limits. Grading contracts, as was pointed out in these columns, have recently been let at 1914 prices.

As to surfacing costs it was emphasized that the materials item makes an important difference. This was believed to be still too high, especially when compared with the lowered price of labor. Here high freight rates are an important element. The point to remember, however, is that on kinds of work involving chiefly labor, costs are down to pre-war levels.

For Constructive Thought on Transportation

AT NEXT week's meeting of the National Council of the U. S. Chamber of Commerce there will be discussion of a proposal that Congress create the position of "Commissioner General of Transportation." The duties of the office would be to take a constructive attitude toward the conservation and development of the transportation facilities of the country, and to see that the public's rights get adequate consideration in all transportation matters. At present the railroads receive government attention only through regulatory bodies—the Interstate Commerce Commission and the Railroad Labor Board. There is no agency which constructively considers the country's transportation agencies. Waterways and highways, in this respect, are in a more favorable position. The Corps of Engineers has a fostering care of waterways. (So has, we might venture to say, the log-rolling politician.) The Bureau of Public Roads is doing a great constructive work for highway development.

Obviously the railways need to have the same fostering care of the government. Their future is as vital to the prosperity of the country as are industry, agriculture, mining and other branches of our national economy to which great government departments and bureaus are devoted. That such care is not likely to come from bodies that are essentially regulatory in spirit is evident.

The proposal of the Chamber, therefore, rests on solid ground. There will be disagreement in detail. For example, this journal does not favor the erection of new independent establishments; the new office, as we see it, should be in the Department of Commerce. Again there will be points that will need long study; should the new office take away some of the constructive functions of the Corps of Engineers on waterways, and of the Bureau of Public Roads on highways?

Undoubtedly there will be classification of many points at next week's discussion. The basic idea, though, is sound.

Federal Influence on Motor-Vehicle Laws

A MEANS of putting teeth in motor-vehicle laws and bringing about uniformity in vehicle legislation has been suggested by a highway engineer of the Middle West who has experienced difficulty in securing adherence to the weight restrictions of his state. He proposes that the federal government require definite vehicle laws to be enforced on federal-aid roads.

In the recently enacted federal-aid highway law definite obligations are placed upon the states to supply adequate funds for maintenance of federal-aid roads. It is now suggested that the federal highway Act might go further and authorize the expenditure of federal-aid funds only when the states agree to enforce regulations limiting truck weights and speeds. In other words, weight regulation would rank with maintenance as a reason for withholding federal-aid in case of failure to live up to agreement. If a state were made to realize that future federal aid were contingent not only on adequate maintenance but on strict vehicle-law enforcement, it is probable that the present laxness in the latter respect would disappear.

Aside from the effect in forcing the states to administer properly their motor-truck laws there are other arguments favoring the suggestion. We know of many roads ruined by excessive loads and high truck speeds. If vehicle-law enforcement is vital in order to get reasonable life from surfacing, why is not such enforcement as legitimate a subject for contract agreement as maintenance? Both factors bear on the service which the people are to get from the federal expenditure.

Another attractive feature of the proposal is that it would tend to bring about a uniform motor-vehicle law in all states or, at least, in large sections of the country.

Obviously, there are objections. Without doubt some

will cry that it invades the police power of the states. Others will protest that if maintenance be adequate the federal government has no interest in what causes the maintenance costs. Still others will resent greater federal interference, and others will claim that a uniform law is impossible.

The suggestion, though, has merit and reason. We should like to see its advantages and disadvantages fully discussed.

Responsibility and Pay

IN THE court inquiry into the collapse of a theater in New York, described in our issue of Dec. 8, 1921, p. 954, it developed that the plan examiner of the Building Department who approved the design for the theater is paid $1,944 a year. The magistrate was shocked. "Your approval of the plans was final? There was no one else to check or question your conclusions?" he asked the examiner. Evidently he thought that technical knowledge worth less than $2,000 a year is not of high quality or dependable. To the extent that the design for the structure played a part in bringing about the collapse and causing the death of seven workmen, the examination and approval of the plans obviously connected itself in the magistrate's mind with the fatal outcome. A much more serious duty and responsibility rested upon this examiner than his salary of $1,944 indicated, as the magistrate expressed in the remark: "A man carrying your responsibility and exercising it properly," said the magistrate, "should receive at least $10,000 a year."

Such is the opinion of a judicially minded layman on technical responsibility and adequate compensation therefor. Engineers themselves have urged this view time and again, and have pointed out that placing heavy responsibility on men for grossly inadequate pay leads very surely to deterioration and debasement of the work. But public authorities are deaf to this argument, and so are many private employers, unfortunately. Engineers in river and harbor work, the technical men of the Bureau of Standards, and the Patent Office experts are as pertinent examples as this particular building-plan examiner. Their fight to prevent destruction of the service by inadequate compensation has generally been in vain. And so, in another field, has the classical case of the bank teller always remained in *statu quo*, in spite of case upon case of the unhappy results.

It will not do to depend upon the wisdom of the employing authority to fix adequate compensation, and engineers will make no progress in their fight unless they continue the course initiated some years ago and stand in concerted action against inadequate compensation within the profession.

The foregoing paragraphs were written before the shocking collapse of the Knickerbocker Theatre at Washington. At this moment we do not know much about that accident or the design of the roof that failed, but we do note a general disposition to blame the building department of the city for laxity. "Responsibility for the dreadful catastrophe," says the New York *World*, "comes home at last to the government of the District of Columbia and its building laws and their enforcement."

And yet the head of that building department receives less than a dapper, responsibility-free bond salesman, and the wages of the man who passed on the Knickerbocker design or repairs, if there were any, would be despised by many a skilled laborer with only himself to care for.

When hundreds lie dead, the people—and their newspapers—see clearly the importance of their building departments. When budgets are being made, short-sighted tax-payers loom large in the legislator's mind. What was it Kipling said, before the great war, of the British public and its soldiers—

"Oh, it's Tommy this and it's Tommy that, and it's Tommy, damn your soul!
"But it's 'the thin red line of 'eroes' when the drums begin to roll."

After-Thoughts on the Hardwood Lumber Decision

IN THE month since the decision on the Hardwood Lumber case was announced, there has been a maturing of views. The panicky impression of the first few days has disappeared. In its stead has come a settled conviction that the decision is of limited application, that it was predicated on the showing that the association had used statistics as a basis for advice on future action, and that a favorable decision may be expected when there comes before the court an association which has confined its activities to the collection and distribution of data regarding closed transactions. This, by the way, was the view expressed editorially in *Engineering News-Record*, Dec. 29. This view, however, is not universally held. Naturally, some associations feel on unsafe ground. Six of them (we do not happen to know the nature of their work) have been abandoned, so the U. S. Chamber of Commerce reports.

While the less alarming interpretation has been gaining ground there has also been developing the conviction that safety in statistical activities lies in the direction of publicity. But this thought, too, is not without opposition. Some manufacturers fear that the statistics will be misinterpreted by consumers, and that the misinterpretations will lead to unintelligent buying, unsettled markets, and to unwarranted pressures put on producers.

We, ourselves, are not fearful of dire results. Unsettlement there may be in the beginning, but it will be the precursor of a more stabilized business. The consumers will soon learn to interpret the figures intelligently. Then will come buying in the light of fact. More important, though, will be the confidence with which the manufacturer will be regarded. Now he is looked on as having leagued with his fellows for the exchange of data to be used against the buyer.

We should think that the study of the operation of open exchanges would tend to quiet the fears of those who oppose publicity for statistics gathered by associations. In the food-supply field, for example, we have a long chain of published facts, beginning with government crop reports, down through shipments and sales and prices. We believe that it is generally agreed that this publicity is a gain to the entire industry and conserves, as well, the interests of the public.

Publication of association figures is in harmony with the spirit of open exchanges and would remove the basis of criticism which not only has prompted the government suits but may result in legislative action. The public, it is apparent, is distrustful of associations which gather figures for their members' private use.

Open-Well Piers and Subdivided Warren Trusses of Bismarck-Mandan Bridge

Foundations on Clay at Depths Up to 70 Feet—Tilted Pier Righted by Help of Blasting—Riveted Simple Spans With New Web Type—Disadvantages of Continuous and Pin-Connected Construction

By C. A. P. Turner
Consulting Engineer (C. A. P. Turner Co.) Minneapolis

THROUGH North Dakota the transcontinental highway from the east to the Yellowstone National Park is known as the Red Trail. The crossing of the Missouri River at Bismarck by ferry—hitherto the only means of crossing in summer—is impracticable, however, in high wind or at time of flood. During winter the river is passable on the ice, but it is impassable during the time of ice formation and breaking up. Due to the fact that the river varies anywhere from 1,500 to 3,000 ft. in width, presenting a bluff on one side and from one to three miles of river bottom on the other, bridge crossings are infrequent and expensive. These conditions controlled the construction of the Bismarck-Mandan bridge, now nearly completed.

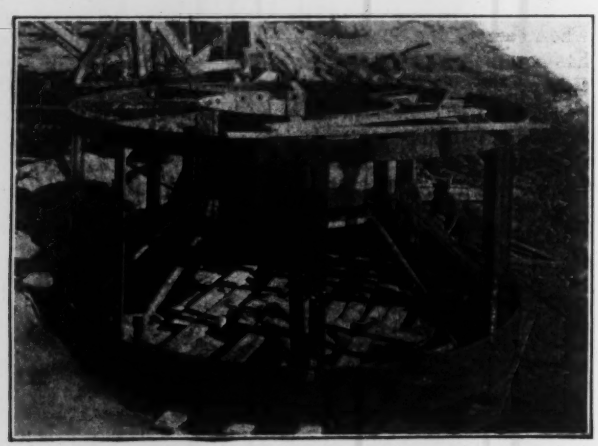


FIG. 1. PLACING BASE FORMS ON SHORE-PIER CYLINDER

The river bed is formed of silt, shifted at each succeeding flood period and deposited at the subsidence of the high water. As the river rises it commences to dig out its bed so that the depth of the water is increased downward as much or more than in an upward direction. It is limited in its capacity for channeling by a stratum of shale clay which extends for many miles up and down the river, at an elevation varying from 30 to 90 ft. below low water. Bridge foundations must be carried down into this clay if they are to remain permanent and unaffected by the scour at flood periods.

A location about a mile below the Northern Pacific R.R. bridge at Bismarck was adopted for the new crossing. It lies in the most direct line from Bismarck to Mandan, is far enough below the Northern Pacific bridge to meet the requirements of navigation, and avoids the slip of the clay bank which is causing the Northern Pacific R.R. trouble with its east pier. The depth of clay is somewhat greater than found at the upper site. The bridge proper consists of three main spans, 476 ft. center to center, with concrete approaches on curve, about 400 ft. on the east and 600 ft. on the west end. The deck provides a roadway 27½ ft. wide and two 6-ft. walks.

Foundations.—Because there are relatively few logs and boulders in the bed of the stream above the clay stratum, the open-dredging method of sinking piers was adopted. A somewhat novel design was employed: The bases of the river piers, 23 x 60 ft., by 14½ ft. deep, are framed with a steel skeleton built up on the cutting edge, the latter made up of a 24 x ½-in. plate outside, a 24 x ⅜-in. plate inside bent 40 deg. from the vertical, and a 3 x ⅜-in. bar between. Forms were attached to the frame and the whole filled with concrete stiffened by reinforcement. Three dredge pockets were left in the base. Above the base, the pier was narrowed down to 16 ft. width and above low-water line, where ice action commences, to 12 ft., and still higher to 10 ft. in the form of two cylindrical columns.

Twin cylinders having a base 20 ft. in diameter by 10 ft. deep with dredging pocket 9 ft. in diameter constitute the shore piers. Sinking the piers progressed at the rate of 1 and 3 ft. a day until clay was reached, when some little delay and difficulty was experienced in sealing the piers, as the clay was too compact to dredge with a clam. Without at least 10 to 15-in. penetration of the cutting edge into the clay, the dredging pockets could not be sealed against the inflow of silt through irregularities in the surface of the clay. Pier 3, at depth of 70 ft., gave additional trouble; the clay stratum was inclined and the pier tilted about 30 in. The clay on the high side of the pier was loosened by driving points consisting of old boiler tubes closed by a blacksmith into the clay near the cutting edge, lowering dynamite cartridges into the holes so made, and shooting several at a time. After the piers were sealed and pumped out, they were carried to the desired depth in the clay by chopping out the clay with mattocks.

The pier shells had been reinforced for air should it become desirable to employ it in sealing. All piers were sunk in the open, and air was used in sealing only the west shore piers in the dry, as insisted upon by the U. S. Bureau of Public Roads.

Fig. 2 shows the steel framing for one of the twin cylinders of Pier 1. The frames for Piers 2 and 3, rectangular boxes, were made up in the same manner. After the base sections were concreted, the piers were sunk by progressively building up and dredging out. (Figs. 3 and 4). Fig. 3 shows one stage of sinking of Pier 1; here the north (near) pier has been sunk only a few feet, the top of the base still showing above water, while the south pier has progressed farther and the upper section of the shaft has been built up from the base. In Fig. 5, Pier 2 is seen complete. The two shafts, which are heavily hooped and reinforced, are of enormously greater strength than the ordinary masonry pier, while costing far less because of their lesser bulk.

Clearance for Navigation.—Following the Missouri

River Commission report of forty years ago, the practice of the War Department has been to approve plans only as they provide for at least 50 ft. clearance above June high water. With railroad and truck competition, steamboat transportation on the upper Missouri river is found today to be feasible only with the internal combustion engine, so that the 50-ft. clearance required for the smokestack of the old-fashioned coal-burning steamer is today unnecessary. Through the active interest taken in the structure by Capt. I. P. Baker, principal owner of the Benton Packet Co., of Bismarck, the only company now commercially engaged in the transportation of freight on the upper Missouri by boat, this old requirement for headroom was reduced by the War Department to 38 ft., although navigation interests maintain that 25 ft. is ample for any commercially feasible craft navigating the river today. It may be expected that further reductions in the excessive clearance required for bridging the Missouri will be permitted in the near future, as it is an item of material importance in reducing the high cost of railroad and highway structures across this stream, now necessary to give the prescribed clearance at a reasonable grade.

Superstructure.—The superstructure of the approaches presents little that is novel; the spans are uniformly about 34 ft. center to center of columns, and the pedestals in general rest upon piles cut off at the permanent water line. The main spans, however, are decidedly interesting.

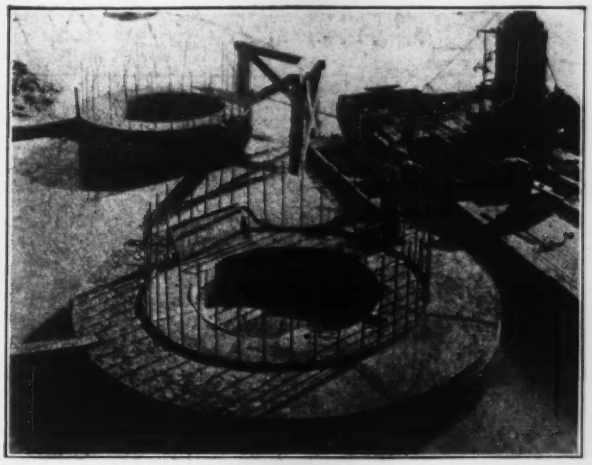
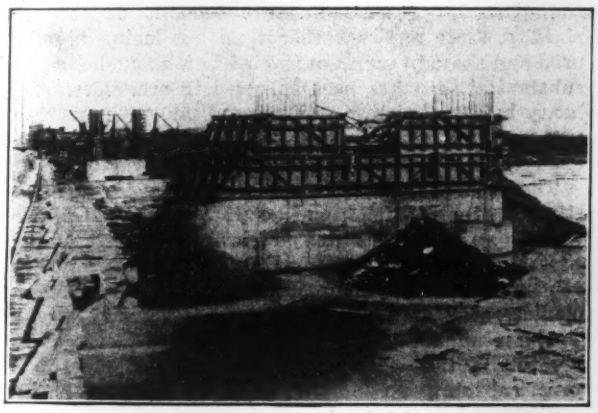
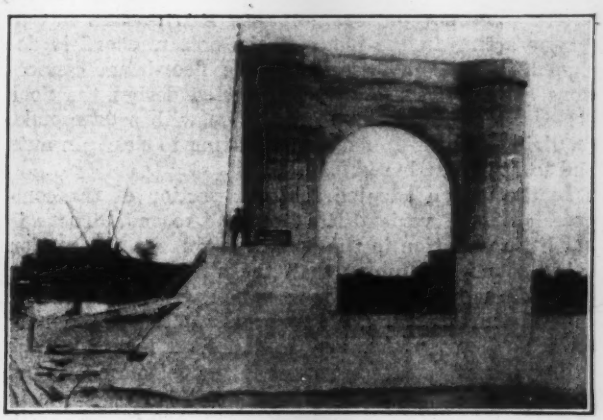


FIG. 2. TWIN CYLINDERS OF SHORE PIER AT TWO STAGES OF SINKING





FIGS. 3 AND 4. A RIVER PIER; FORMS OF A LOWER SECTION, AND COMPLETED PIER

Two primary questions of bridge economics presented themselves: simple spans or continuous construction, and riveted or pin joints.

Simple or Continuous.—Reduction in expense of erection for the center span was the main argument favoring continuous spans. Offsetting this would be the additional cost of shop work and additional weight of metal, estimated at about 30 per cent over that required for simple spans.

The so-called renaissance of continuous bridge construction appears to the author to be based on misconception of the elements of relative economy in a comparison of the two types. In the simple span, maximum moment occurs where the shear is least; accordingly, relatively great depth may be utilized in resisting moment, and heaviest chord members occur where the weight of the web members approaches a minimum. In the continuous type the heaviest and longest web members are required at the support, where the moment is numerically greatest. Hence the continuous structure labors under the disadvantage of a much heavier web than the simple span, and the economic depth for the simple span is therefore greater than that for the continuous span.

The estimated difference between the two types, designing each as economically as possible, was approximately 30 per cent of the simple-span design, the continuous design being the heavier by that amount and more expensive by at least 20 per cent.

Riveted or Pin-Connected.—Some 25 years ago there was considerable controversy between American and continental engineers regarding the relative economy of pin-connected structures as against riveted structures, the latter being used almost exclusively in Europe and pin-connected structures being generally adopted in America.

It is submitted that the riveted design adopted for the Bismarck-Mandan bridge is more economical from the standpoint of weight of metal involved than a pin-connected design, notwithstanding the fact that riveted bridges as designed by European engineers are in general heavier than typical American pin-connected bridges. For the same skeleton the weight of details depends in a large measure on economy in splicing the

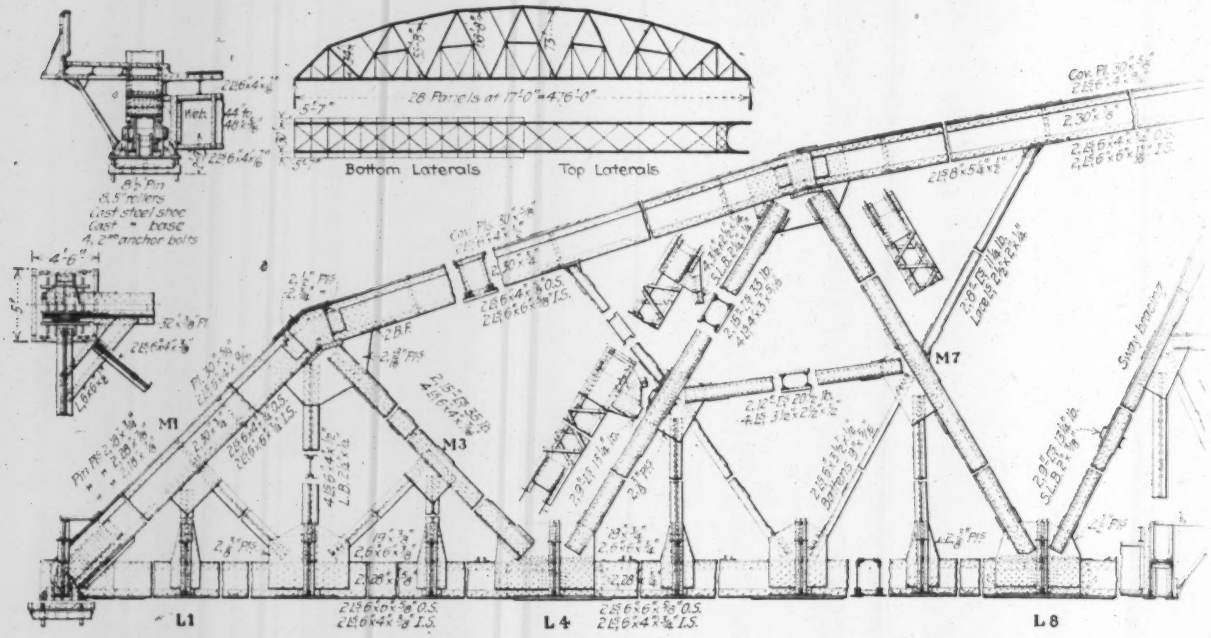


FIG. 5. SUBDIVIDED TRIANGULAR TRUSSES

main sections and the complexity of the details involved. In the pin-connected bridge, when a first-class lateral system acting in the plane of the bottom chord is designed, complicated details of the floor-beam connections are involved. With the riveted design the floor beams are made of full cross-section with square ends, requiring no bent-up flanges or cutting to clear pin nuts and to fit eyebar heads.

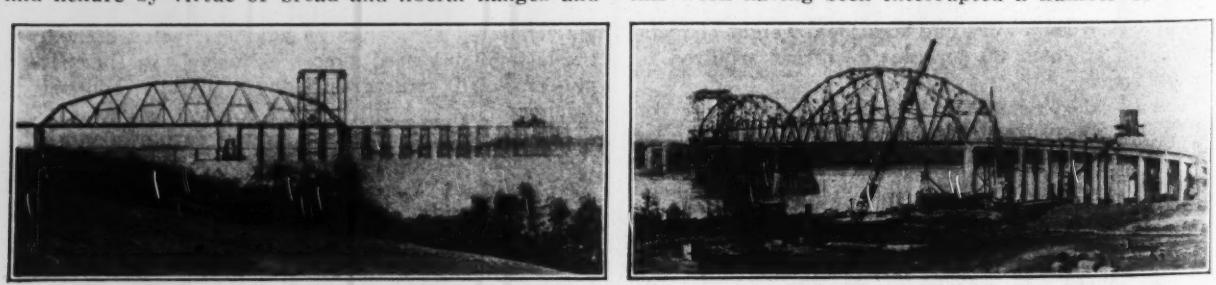
In the design adopted the cross-section of the compression chord varies little from end to end. There is but little variation in the bottom chord, the end section being somewhat lighter than the others. The lengths of uniform section are four panels, by virtue of the subdivision adopted. This spaces the splices of the main sections 68 ft. apart, and in the total length of the bridge there are but six splices in the bottom chord and seven in the top chord. Thus the number of joints in the bottom chord is no more than in a 140-ft. span with seven 20-ft. panels, and because of the reduction in the number of these joints the percentage of details is relatively lower than in the pin-connected type.

The make-up of the truss is completely shown in the general detail drawing of the truss submitted herewith. It differs in some minor respects from common practice in presenting balanced sections in the compression members, which are well designed to resist both torsion and flexure by virtue of broad and liberal flanges and cross diaphragms inserted at suitable intervals. The lacing itself presents a large amount of torsional rigidity, since angles rather than flat lacing bars are used and these in turn are riveted in a manner far more substantial than has been followed in other designs of heavy bridge structures. Double shear on the rivets of the connections of all main joints is secured by forked ends of the members.

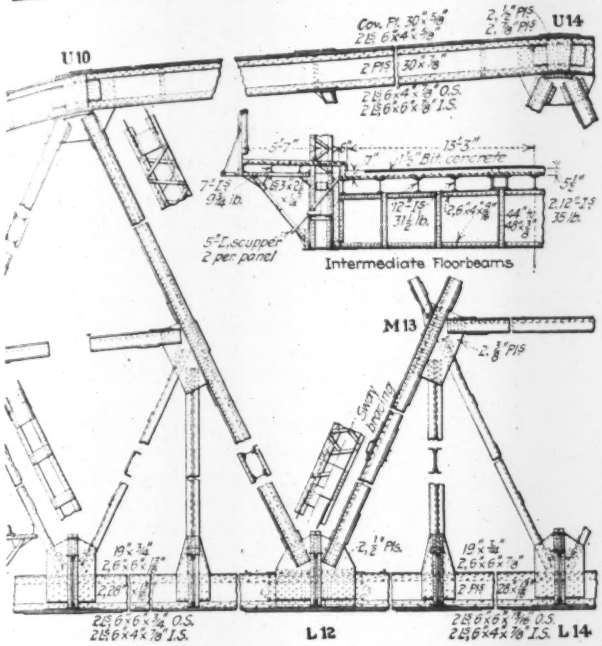
The type of truss is one originated by the writer to eliminate the multiplicity of nominal members, i.e., those that do no work except to break up the length of compression members, to be found in the Baltimore type; to render the triangulation a closer approach to that of the equilateral triangle; to reduce the secondary stresses to the minimum amount; to simplify and facilitate field erection by the reduction of the number of joints to the practical minimum limit.

Field Advantages.—In erection this form of truss proved fully as advantageous as in its design effect. At the very first, the erection men, being not used to the work, "cussed" the design; but very quickly they got the hang of putting the work together, making phenomenal speed even on the first span. The long members and few joints brought rapid progress.

Erection started in July, after driving of the pile falsework for the first span on the Bismarck side—this work having been interrupted a number of times



FIGS. 6 AND 7. SUPERSTRUCTURE ERECTION. LEFT, MAIN TRAVELER STARTING SECOND SPAN; RIGHT, TWO SPANS COMPLETED



WITH TOP-CHORD BRACES

by ice and high-water damage. The first span was completed late in September. In the meantime falsework had been driven for the second span and work started immediately there. Steel was placed by an outside traveler, which may be seen in one or two of the photographs. Between four and five days were required to place the shoes of the second span and grout them, set the floor system on the blocking, and lay down the bottom chords. Then only 3⅜ days were required to erect and couple up the rest of the span (above the floor).

The general opinion of the erecting men seemed to be that the triangular type of truss could be erected 1½ times as rapidly as an ordinary pin-connected span, and with far greater safety to the men putting it up.

A small traveling derrick frame running on the falsework was used ahead of the main traveler to place the floor and bottom chords. All erection above the floor was handled by the outside gantry traveler, the hoisting engines for which were located on the smaller traveler. Yard handling of material, from the ground alongside the approach to cars on the bridge floor, was done by locomotive cranes.

The work is being executed under the direction of the Highway Commission of North Dakota, Gov. Lynn Frazier chairman, W. H. Robinson secretary and chief engineer. The writer's firm, the C. A. P. Turner Co., of Minneapolis, acted as consulting and designing engineer. The Foundation Co. carried out the foundation work and the American Bridge Co. the fabrication and erection of the superstructure. The work was financed with federal aid, administered by the Bureau of Public Roads, E. O. Hathaway district engineer and Thos. H. McDonald director. The Government contributes half and North Dakota one-third of the cost; the counties of Burleigh and Morton each contribute half of the remaining amount. E. G. Patterson is chairman of the Burleigh County board, and C. P. O'Rourke chairman of the Morton County board.

A noteworthy feature of the enterprise is that the land occupied by the concrete approaches and the roadway from the approach to the city of Mandan was donated by Capt. I. P. Baker of Bismarck, who has been an enthusiastic supporter and promoter of the project throughout, although it might seem that his interest in river navigation would be incompatible with promoting the best connection between the property lying on the east and west side of the river. His view is a broad one—that with better communication there will be more business for the packet company.

Compact Sewage-Works for Annexed District of Rochester

By John F. Skinner
Principal Assistant City Engineer, Rochester, N. Y.

DUPLICATE grit chambers, fine racks, measuring eirs, an air-lift pump well, an Imhoff tank and sludge drying beds arranged concentrically with the tank, all on a lot 132 x 275 ft., comprise the sewage-works for the former village of Charlotte, which was annexed to the city of Rochester, N. Y., a few years ago. The plant is designed to treat from 30 to 180 cu.ft. per minute from sanitary sewers serving ultimately a habitable area of about 800 acres. The present winter population is about 3,000 and the permanent summer population about 4,000. During the summer season there is a large transient summer population brought in by railway and trolley, automobiles, and by boats on Lake Ontario, Charlotte being a summer pleasure resort at the junction of the Genesee River with the lake named. Trolley lines alone have brought as many as 12,000 people to the beach in a single afternoon. The sewers now carry roof and street surface water, but the intention is to exclude the storm water.

The sewage arrives at the works at a level about 12 ft. below the ground surface. It then passes through one of two parallel 4 x 40-ft. grit chambers, at the lower end of each of which there is a cast-iron rack with bars spaced ½-in. apart, set 3 horizontal to 4 vertical. The sewage then passes over a 12-in. Cippoletti weir to an air-lift well 20 ft. deep from which it is raised to the Imhoff tank, the water surface of which is about at the ground level.

A neat operating house, 18 x 30 ft., inside, constructed of tapestry brick lined with sand lime brick and roofed with red concrete tile, houses the machinery, gauges, etc., and serves as an office.

Air is provided for the air lift by three No. 1 Nash hytor compressors direct connected to 10-hp. constant speed motors and feeding into a common header. No air drier or air receiver is provided. A 6- and a 7-in. air-lift furnish the necessary variation in capacity.

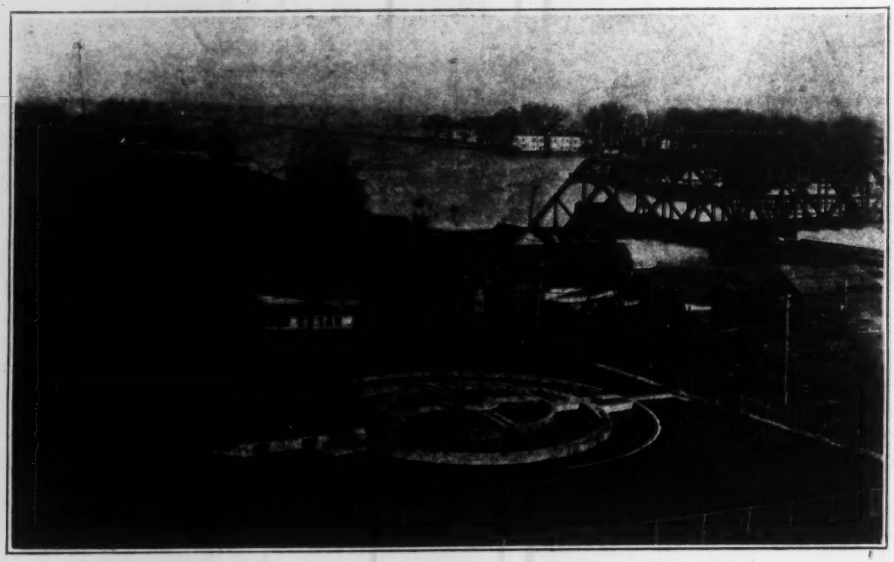
The Imhoff tank is circular, 38 ft. inside diameter, 35½ ft. deep over all, with a total water depth of 30½ ft., a free board of 2 ft. at the periphery and 3 ft. at the central gas well, in which the water surface has a diameter of 9½ ft. The gas well area is 6¾ per cent of that of the settling chamber. The flow is semicircumferential. The volume of settling chamber at low-water flow is 10,284 cu.ft. The sludge capacity below the slots is 11,531 cu.ft., which, for 10,000 population, gives 1.153 cu.ft. per capita.

The sludge will be lifted by air through a vertical 8-in. pipe in the center of the tank. Gates at the top divert the sludge, which only has to be raised against a 2-ft. head, to either side of the tank to two annular

sludge beds 10 ft. wide, concentric with the tank, having a total area of 3,333 sq.ft., or ⅓ sq.ft. per capita for a population of 10,000.

The effluent is discharged directly to the Genesee River, one mile from its mouth, through a 12-in. submerged outlet pipe. The river at this points has a channel 24 ft. deep and is the outlet of 2,200 sq.mi. of territory. In the last seven miles it has falls amounting to 260 ft. so that it is naturally well saturated with oxygen.

The plant was put into operation in October, 1921, being seeded from the Irondequoit plant of the City of Rochester the following month.



GENERAL VIEW OF CHARLOTTE SEWAGE WORKS, ROCHESTER, N. Y.
Effluent is collected in an open drain, located between the two sludge beds, the latter being arranged concentrically to the Imhoff tank.

The plant was designed by the writer and constructed by N. A. Brown, special assistant engineer, under the general supervision of C. A. Poole, city engineer. The general contract was executed by Whitmore, Rauber & Vicinus of Rochester, N. Y.

Tentative Thoroughfare Plan for Cleveland

A map showing a tentative thoroughfare plan for the city of Cleveland, Ohio, bearing date of Dec. 1, has been printed for distribution. It is on a scale of 1 in. to the mile and shows existing thoroughfares, proposed widenings, and proposed extensions. In general the thoroughfare plan is a combination of radial and rectangular street systems, the radial streets centering in the public square at the civic center which has been under development for some years past. There are also some minor radial street systems centering in various quarters of the city. The normal widths for the three main courses of thoroughfares are 66, 86, and 120 ft., these figures including in each case two sidewalks which are respectively 13, 15, and 22 ft. wide each. Put differently, these may be stated by roadway widths as follows: 40 ft., providing for four lines of traffic, all moving; 56 ft., providing for six lines of traffic, four moving and two standing; 76 ft., providing for eight lines of traffic; six moving and two standing. Robert H. Whitten is city plan adviser and C. E. Conley is engineer to the City Plan Commission.

Alternate Plans For Proposed Colorado River Dam

Rock-Fill Made By Blowing Down Canyon Sides From Tunnels or Thin Concrete Arch For Boulder Canyon Dam

BY ARTHUR P. DAVIS
Director, U. S. Reclamation Service, Washington, D. C.

STUDY of the Colorado River Basin from the standpoint of its use in irrigation and otherwise may be said to have begun by the establishment of stations for the measurement of stream discharge in various parts of the basin in 1894 and 1895 by the U. S. Geological Survey. One of these stations was established at Yuma, Ariz., to intercept and measure the discharge of the entire stream, there being no tributaries below this point. It was found that gage height readings had been kept for a considerable period by the Southern Pacific R.R. at Yuma and these were utilized so far as possible, but the shifting nature of the channel made their use of doubtful value, and also to a considerable extent vitiated the records kept at Yuma by the U. S. Geological Survey for the first few years.

After the passage of the Reclamation Act in 1902 the Reclamation Service took up the systematic study of the lower river, provided for more frequent and systematic gagings at Yuma and other points, and made a topographic survey of the lower valleys of the Colorado River from Bull's Head to the Mexican boundary. The investigations above were continued, particularly as regards stream measurements and the survey of reservoir sites and borings at the necessary dams. In the stream measurement work substantial co-operation was extended by the Geological Survey and the results were assembled in the publications of that bureau from time to time.

A more intensive study of the entire basin was inaugurated in 1914 by a special allotment of $50,000 for this purpose, supplemented by annual allotments in subsequent years, and this work was finally assembled in three large volumes of manuscript by John T. Whistler. It included a reconnaissance of practically all of the proposed reservoir sites and irrigation projects in the basin above the Arizona line and the compliation of all existing data including the water filings and water rights throughout the basin. The study did not stop with the rendition of Mr. Whistler's report, but was transferred to the lower basin where the topographic survey of the basin was continued up the river from Bull's Head and a detailed survey made of the proposed reservoir site at and above Boulder Canyon, in the northwest corner of Arizona and below the Grand Canyon.

Borings made in 1903 and 1904 on the lower river

showed that at Bull's Head, Williams Fork, Picacho, and other points tested, the subterranean channel of the river had been eroded to a great depth, so that the foundation of dams at any of these points on bedrock was considered infeasible. In view of this fact and of the silt problem, some engineers were led to conclude that storage at any point in the lower basin of the Colorado River was not feasible. Further consideration, however, led to the evolution of a plan for building at Boulder Canyon a high dam without excavating the river to bedrock, which owing to the peculiar topography of the site seemed to be at least worthy of consideration. At this point the canyon is about 300 ft. wide at the river level, and cliffs of massive granite reach upward nearly vertical to a height of over 2,000 ft. above the river. Plans were evolved for a loose rock dam at this point constructed by the following method:

Loose Rock Dam Details

It was proposed to pierce the cliffs with large tunnels on each side of the dam site a short distance just above the level of the river at medium stages in order that the river might be diverted through these tunnels at moderate stages if desired. These tunnels were to be equipped with controlling works. For a dam say 600 ft. above the river level it was proposed to provide slopes for a rock fill dam of slopes of 1 on 3 on each side when counted from bedrock to summit, with a top width of 30 ft. This would mean that the thickness of the dam upstream and downstream at the river bed would be 3,630 ft., or nearly three-quarters of a mile. The cliffs were to be pierced with small tunnels parallel to the river at numerous points well above and outside the lines of the dam in order later to be filled with powder and exploded to blow the rock from these cliffs into the river for forming a loose rock dam. At a point just above where the upstream slope of the dam would intersect bedrock a tunnel on each side of the river was to be filled with powder and exploded, throwing the rock into the river bed in such manner as to form a cofferdam and divert the river into the diversion tunnels. This cofferdam was to be faced with smaller rock in order to serve its purpose and then the river turned over the cofferdam, which it would proceed to destroy by scouring the bed of the river at the lower toe and rolling the rocks of the dam into the cavity thus formed.

After such action had proceeded to a point of comparative quiescence another blast from higher tunnels on both sides of the river would blow additional quantities into the river just below the cofferdam and the river required to work upon this mass for a short time. With the high head thus formed the scouring effect of the water upon the toe of the rock fill would be very powerful and would carry away all the finer material, but the large blocks of granite that would thus be provided could not be carried by the river but being undermined would be settled deeper and deeper into the river bed.

This process would be repeated in such manner as to secure the largest possible action of the water in scouring out the foundation and settling the large rock from the cliffs as low as possible into the foundation. This proceeding from upstream to downstream would pave the foundation progressively with large rock as deeply embedded as possible. The process of blowing rock from the cliffs above by means of tunnels parallel to the river and packed with black powder would be repeated at such points that the required rock fill would be built as nearly as practicable to the height desired on the required slopes, the river being used to the maximum extent in settling the rock into the foundation and all surplus waters drawn off through the tunnels. It is obvious that masses of granite could be secured in this way very much larger than could be feasibly moved by ordinary mechanism.

During the early stages of construction when the mass is of moderate height it would be necessary to take the flood waters of the river over the structure, and this action would be used to the greatest possible extent in paving the foundation with the heaviest rock obtainable.

As the structure increased in height the storage above it would increase in volume rapidly, and at moderate heights the storage capacity and the tunnel capacity combined would be adequate to prevent the overflow of the dam in times of high water after such overflow became undesirable.

When this structure had reached the designed height and slopes, the entire upstream face would be brought to an even slope by depositing smaller rock until the surface was smooth enough to be paved with concrete. A concrete pavement would then be provided of considerable thickness and reinforced with steel. This would cover the entire face of the dam from the river bed to the top and would be securely sealed to the cliffs on either side to prevent percolation through the dam so far as practicable.

Other Considerations

Prior to placing the cofferdam or any of the rock fill, it is proposed to drive a row of steel sheet piling as deeply as practicable across the upstream toe of the dam to be later connected and sealed firmly to the toe of the concrete pavement on the water face of the dam.

The placing of the rock fill should be completed a year or more before beginning the construction of the concrete pavement. This time would be occupied in sloping up the water face preparatory to placing the pavement. The construction of the pavement would be so planned that the sealing of the pavement to the rock of the abutments would be the last finishing touch of the dam so as to give the mass the maximum time for settlement before making this junction.

The control of the river during construction and immediately after would form a pond of varying magnitude just above the dam, filled with the muddy waters of the Colorado and these would deposit their sediment on the river bed and upper toe of the dam in such manner as to form something of a seal and tend to prevent water entering the foundation at any considerable velocity.

This plan of construction was discussed with Secretary Lane in obtaining authority for the extensive investigations of the Colorado River in 1914. It had previously, and has since, been discussed by the author with many engineers in order to bring out, if possible, any weak points connected with the plan, and some of the details of this plan have been modified as the result of such discussions. They are of course subject to further modification by further thought, and especially by the experience obtained during construction. The plans were worked out in more detail and estimates made on the basis of such a structure as compared with a dam built of concrete under the direction of the chief engineer of the Reclamation Service by John L. Savage and his assistants.

cially by the experience obtained during construction. The plans were worked out in more detail and estimates made on the basis of such a structure as compared with a dam built of concrete under the direction of the chief engineer of the Reclamation Service by John L. Savage and his assistants.

These studies seemed to indicate that no material saving could be made by adopting such a plan as compared with a concrete structure carried to bedrock providing the latter proved feasible at all. A depth of 135 ft. to bedrock while presenting serious difficulties in foundation work, is believed to be entirely feasible if proper preparations are made and proper plans are followed.

It is not believed that within reasonable cost it is either feasible or necessary to divert the entire flood flow of the Colorado River, which may at times reach 200,000 sec.ft. The alternative plan is to design a thin arch of such radius and dimensions as to be safe with its base upon the foundation rock and its summit about 40 ft. above the low-water level of the river. Within this limit the canyon is quite narrow, being at all points less than 350 ft. in width, and therefore a structure of short radius and light section would be safe. After the construction of a cofferdam and of diversion tunnels of sufficient capacity to carry the ordinary flow and moderate floods of the river, excavation would be undertaken of only sufficient width to secure foundation for this thin arch, and this would be completed and the arch poured during the nine months or so in which it would be possible to unwater the foundation by means of the tunnels and cofferdam.

This thin arch would serve as a subsequent cofferdam and also for the heel of the masonry structure to be built. If this were overtopped by floods, they would fill the pit with water only, which could be quickly pumped out when the flood had passed and the excavation of the additional foundation and placing of foundation concrete could proceed at all times when the river flow is below the capacity of the tunnels; this would be possible without serious or expensive interruptions except in the brief high water season of May and June.

The method just described for meeting foundation conditions in Boulder Canyon has been successfully carried out in placing the foundations for the Shoshone and the Arrowrock dams, the highest yet built by the Reclamation Service. The depth to foundation at Arrowrock was about 100 ft., and on the Shoshone about 90 ft. At Boulder Canyon the depth is greater and the quantities are larger, but it is practicable to assemble a much larger construction outfit and to make more strenuous speed than was found necessary at either of the two locations mentioned. These experiences have led those familiar with them to conclude that the placing of the foundation in Boulder Canyon for a concrete dam by the above method is feasible and not unduly expensive.

If this is true, the plan of blowing the cliffs into place for a rock-fill dam is not necessary to solve the problem. It may, however, have advantages of economy, but this is difficult to predict on account of the unprecedented character of the operations.

A structure necessary to solve the problem of the Colorado River by a dam in Boulder Canyon is so high and so far beyond the precedents that it seems advisable with due care for engineering safety and economy, to avoid going outside of such precedents so far as possible. For this reason it seems to be desirable to build the structure of concrete in accordance with well established theory confirmed by numerous and varied precedents. A rock-fill structure might be cheaper but our experience is so limited that we can not be sure that this will be the case. If some unforeseen difficulties such as blow-outs under the rock fill should be encountered, its expense might even be greater than that of a concrete structure, and we cannot be sure that it would be entirely safe.

Electric Control and Operation of Water Valves at Buffalo

By George C. Andrews
Water Commissioner, Buffalo, N. Y.

THE Bureau of Water of the City of Buffalo has just equipped 15 of the 36-, 42- and 48-in. valves in its distribution system with electrical operation and control apparatus. Ten of these valves are on the discharge mains leading from the pumps at the Massachusetts Ave. pumping station and five on the boundary line separating the high and low service on the 60-in. discharge main running up Jersey St. from the new Col. Francis G. Ward pumping station. The valves at the Massachusetts Ave. station were so equipped to allow quick and immediate opening or closing to simplify the changing from high or low service, which under former conditions required many men for several hours, and for emergency use in case of breaks in the pumps or their discharge mains. The valves on the Jersey St. line are to be operated daily to allow the main to be used on either the high or low service as occasion may demand. All these valves are in manholes underground and from ten to forty years old.

The present Massachusetts Ave. pumping station is situated on the site of the original station on the east bank of the Black Rock Ship Canal, with the Niagara Falls Branch of the New York Central Railroad directly east of it. The pumps are approximately 40 ft. below the street level. The discharge mains pass under the railroad tracks and then ascend the grade on a slope of 45 deg. This station has six 30-m.g.d. pumps, each provided with its own discharge main. None of the discharge mains are equipped with a check valve in the station because of lack of room, so that it is necessary to close the street valves when a pump is not running, or else depend upon the pump valves to hold the pressure. Since the original station was built several series of pumps have been installed, each with its independent discharge main, and the side hill and adjacent streets contain a maze of mains and valves which were very confusing to operate by hand. Over thirty large valves are located in one block and while a model of the installation is kept for the information of the employees few were able to operate the correct valves for each pump or service without more or less trial. By careful study ten valves were found which control all pumps and allow either high or low service and these valves have been equipped with electrical operating and control apparatus. These valves are located in one block, in and on each side of the street, and are controlled from one switchboard, located in the gate house at the top of the stairs leading down to the station. The other valves are left permanently open or closed.

Each valve has been equipped with a Dean control unit, which consists of a high torque, totally enclosed

watertight motor, reduction gear and limit mechanism in one cast-iron watertight case. There are five different styles of mountings, allowing the unit to be mounted directly on a new valve yoke, or on an attachment to an old yoke or on a channel iron set into the manhole walls. Driving connection is made by either bevel or spur gears between the Dean unit shaft and valve stem, the ratio in all cases being such as to close the gates at about 3 in. per minute, allowing for emergency closing.

The method of control on the Massachusetts Ave. section is from stations mounted on the main switchboard in the gate house. This board contains ten control stations, ammeter, volt meter, switches and fuses, and indicating lights. The indicating lights show by red and green lenses whether the valves are open or closed.

GENERAL VIEW OF DEAN ELECTRICAL VALVE OPERATING AND CONTROL DEVICE

The control device was attached to the old valve by welding the bearing pad to the old yoke.

Current is conveyed from units to control stations by steel taped, lead covered Park cable laid directly in trenches in the ground about 12 in. deep. The connections are made to the Dean units so as to be absolutely watertight. For supplying this section, current is furnished at 220-volt 25 cycles, single phase, and transformers are installed of sufficient capacity to operate two valves under their maximum operating condition at one time, or four at one time under normal operation.

The motors are so wound as to start closing the valve at a speed of approximately 6 in. per minute, and to complete the closing at a speed of about 3 in. per minute, or less, according to the velocity of the water through the gate.

Each valve is equipped with an entirely new and novel form of Dean mechanical valve position indicator, attached directly to the valve stem, showing at a glance the actual turns that the valve is open. Stenciled on the Dean unit and on the manhole frame in large figures is the number of turns required to completely open the valve, so that by reference to the indicator the exact position of gate is known. The control units are provided for hand operation in case of failure of current.

At the Jersey St. section four of the five valves are controlled from two points: One in the central station in the Lakeview Ave. storehouse, and the other is mounted in a cast-iron street pedestal adjacent to the curb. This pedestal contains the control station and relay panel, together with indicating lights. On the switchboard in the Lakeview Ave. storehouse is mounted the necessary remote control stations, indicating lights, switches, etc. The current used for the operation of the Jersey St. valves is taken from the generating equipment at the Col. Ward Pumping station, and is 220-volt single-phase, 25 cycles.

No. 1 Valve is equipped with a Dean electrical position indicator, mounted on the switchboard, the needle of which shows the movement of the gate from open to close, so that its exact position can be noted from the board, although the valve cannot be seen from that point. This is highly desirable as the valve may be used to bleed from high to low service. Special manhole covers marked "electrically controlled valve" have been provided for the manholes.

The complete installation was recently tested under operating conditions when the average speed for opening and closing was eleven minutes.

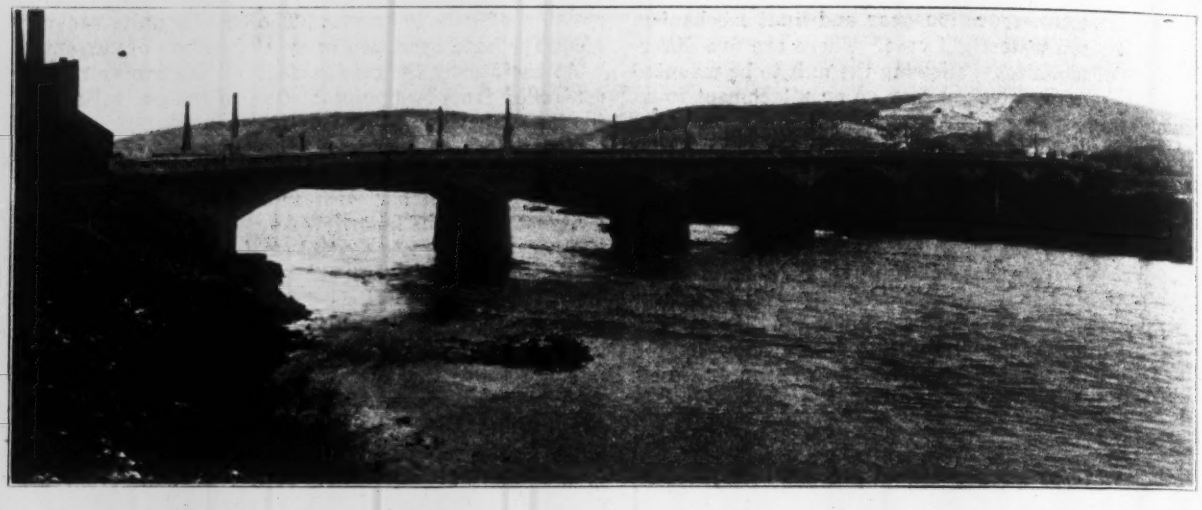
A complete operating schedule has been laid out whereby every valve is completely open and closed once a week, thereby insuring their being in perfect operating condition. A full report of this test is made on a card and sent to the engineer in charge of mains. At each switchboard is posted the valve layout with legends fully explaining what each valve controls and operating directions, so that, in case of emergency, a valve can be operated by any person of average intelligence. All valve controls on the switchboard are provided with locks and keys, kept at the storehouse. In case of emergency, by breaking a glass on the control, the lock can be opened without a key.

The great advantage of the installation is that it gives complete and immediate control of the mains at the Massachusetts Ave. station, and it has also eliminated the objection which the National Board of Fire Underwriters has had to the discharge system there, without the construction of a new discharge system and valve house which they have long recommended. The equipment of the Jersey St. line allows the daily utilization of two discharge mains on high pressure from the Ward station, thereby lessening the risk of interruption of water service when the Massachusetts Ave. station is shut down entirely.

The complete contract was undertaken by Payne Dean, Limited, of New York City, the work all being under the supervision of the writer.

1921 Maintenance of Indiana Roads Cost $4,000,000

All of the Indiana state-maintained roads with the exception of a few miles of earth road are in the best of condition, according to the report of A. H. Hinkle, chief of the maintenance department of the state highway commission to Governor McCray. The report, recently issued, covers the fiscal year from Oct. 1, 1920, to Sept. 30, 1921. More than $4,000,000 was spent by the maintenance department during the last fiscal year. Approximately $1,000,000 of this amount was spent on bills contracted during the previous year.



Some Features of the Chemung River Concrete Bridge

Careful Balancing of Design Alternatives and Definite Purpose in Construction Planning—Reinforcement Interlocking, Waterproofing Details and Flood Protection of Plant

PILE foundation design and the problems of expansion and construction joints, drainage and waterproofing, were given especial attention in constructing the seven-arch, reinforced concrete bridge at Corning, N. Y. Incidentally all parts of the bridge are reinforced concrete poured in place even to the foundation piles and the lamp posts on the parapets. The reinforcement is, consequently, interlocked from the piles up through footings, pier shafts, arch rings, spandrel walls and sidewalks to the hand railing and lamp posts. Architecturally, simple, pleasing lines and masses were sought.

FIG. 1. LOOKING ALONG THE SEVEN SPAN MEMORIAL BRIDGE AT CORNING, N. Y.

The structure is 752 ft. long and is composed of seven three-centered segmental barrel skew arches 92-ft. 3-in. span and 11-ft. 3-in. rise. The arches are 41 ft. in width face to face of parapet walls and support a 36-ft. roadway on earth back fill, and two sidewalks 6 ft. in the clear which cantilever 5 ft. beyond the face of the parapet walls. The total width of structure face to face of coping beams is 51 ft. The depth from the crown of the road to the crown of the arch is 1 ft. 8 in., a minimum requirement in placing a 10-in. water main in an earth cushion under a concrete pavement.

Three streams, draining about 4,200 square miles, come together near Corning to form the Chemung River, which is crossed by the bridge. These streams are flashy, and floods come quickly and subside almost as quickly. In the maximum recorded flood of March 14, 1918, the river rose 19 ft. The rate of rise has, at times, been 1 ft. an hour. In computing waterway, the length of the bridge 752 ft. was set as the distance between the dikes, which have contained past floods, and the roadway was set at an elevation which gave an aggregate waterway between piers below springing lines sufficient for the record flood, leaving the arch spaces above springing lines as a factor of safety in case of greater floods.

With the foundation conditions, 2 to 6 ft. of gravel and clay, then stiff clay down to 16 ft., and then hardpan, the first problem was to choose between shallow footings on piles and deep foundations protected by coffer-dams. Because of the flood conditions and the favorable bottom, the advantage was in favor of piles. With piles adopted, the alternatives were wood and concrete and, in case of concrete, they were precast and cast-in-place construction.

The ground was so compact that it was thought that it would be impossible, or at least impracticable, to attempt to drive wood or precast concrete piles. In fact, the piles adopted required 8 blows for a 1-in. penetration under a No. 1 Vulcan Steam hammer, and in some cases this was raised to as many as 12.

While the unit cost of concrete piles was higher than that of wood piles, about half as many were required.

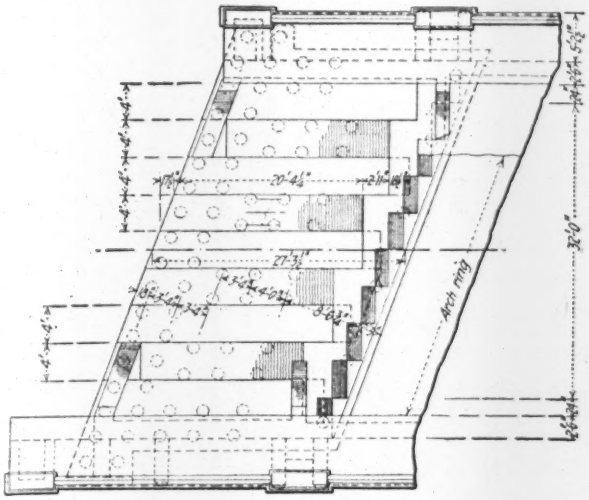


FIG. 2. PLAN OF ABUTMENT SHOWING PILE GROUPING

assuming a bearing power of 35 tons for concrete and of 18 tons for wood. Using fewer piles reduced the area of the pier footing; this saved excavation and also concrete and reinforcement, since the smaller footing could be plain concrete but the large footing, required by the wood piles, must be heavily reinforced. Wood piles would also have necessitated a deeper foundation at some of the piers. The great superiority of the concrete pile appeared, however, in the design of the abutments.

With concrete piles selected, the cast-in-place type had advantages over the precast type as follows: (1) No time was required for curing and the work of driving could be started immediately after the excavation for the first abutment was completed. (2) Reinforcing rods could be inserted immediately after the piles were poured, to bond the footing course to the piles. Additional stubs placed in the footing course lapped the vertical bars in the pier shaft and also in the face walls of the abutments. This arrangement was effective in resisting eccentric thrusts in constructing the arch ring.

The advantage of the concrete piles in the design of the abutments was signal. Here any reduction in length saved a similar length of foundation excavation to a depth of 19 ft., since the abutments were set back into the dikes. The thrust of the arch against the abutments was fixed in amount and direction and to get the vertical load of abutment and fill necessary to resist the arch thrust required a width of abutment of approximately 28 ft. With the amount of eccentric pressure on the outer toe of the abutment, it was impossible to place enough wood piles within the pressure area of the 28 ft. width, without greatly exceeding the safe loading on the piles of the outer row.

In designing the abutment, concrete piles were so spaced under the varying pressure area of the 28 ft. width that each pile was loaded uniformly to carrying capacity. The center of gravity of the cluster of piles under each 4-ft. buttress, Fig. 2, was made to coincide with the resultant pressure of the external loads. It is remarked here that the outer face, of the abutment, was made to act as an abutment buttress in addition to its function as a retaining wall and a support for the sidewalk. The resultant pressure of the abutment and arch thrust is outside of the middle third of the abutment base in the contracted area of the concrete pile plan. Therefore the six piles in a row along the inner face of the abutment adjacent to the arch, theoretically are not taking any vertical load, but these six piles tied to the abutment footing by projecting bars offer a factor of safety against overturning and satisfy a possible discrepancy between the actual and theoretical action. Three 1-in. square reinforcing bars were placed on the side of every pile facing the arch to reinforce the pile in shear and these bars also projected into the footing course. The ends of the buttresses, due to their shallow section in the area of maximum pressure, were reinforced in shear by ⅜-in. stirrups spaced 12 in. apart.

Two features of the arch design stand out. One is the provision for subsequently interlocking the walks and balustrades to the arch ring and spandrels, and one is the provision for expansion, drainage and waterproofing. In general, the bridge was designed to carry 150 lb. per square foot over the roadway. The sidewalks were designed to carry 100 lb. per square foot. The maximum stress in the concrete was set at 650 lb. per square inch and in the steel at 16,000 lb. per square inch.

The arch ring, Fig. 3, 1 ft. 8 in. at the crown and 2 ft. 6 in. at the haunch, was made three centered to conform to the pressure curve of the load. The parapet wall, Fig. 4, 1 ft. 6 in. in thickness supporting the sidewalk and balustrade, is of the buttress type and is reinforced in the longitudinal direction. The reinforcement of the buttress, which is anchored to the arch ring, is carried through the upper plane of the sidewalk beams in line with the buttresses and furnishes the necessary reinforcement for these beams. The depths of these beams, to satisfy architectural considerations, gave a very low shearing stress and no additional reinforcement was necessary. The outer 1 ft. 6 in. lamina of the arch ring, upon which the spandrel wall and sidewalk sit, was made 8 in. deeper than the arch

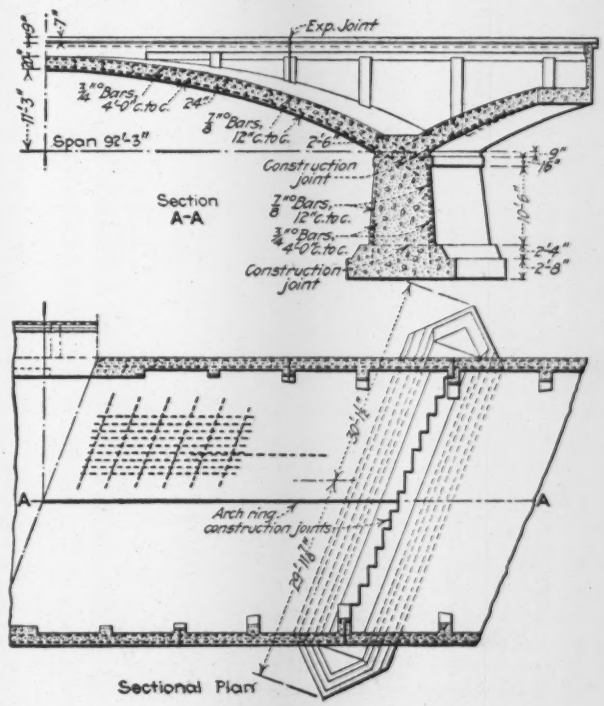


FIG. 3. ARCH SECTION AND PLAN EMPHASIZING CONSTRUCTION JOINTS

ring proper at the crown, and 12 in. deeper at the haunch to carry this extra loading. Poured simultaneously with the half width of the arch ring, it formed a suitable construction joint from which the spandrel wall could be run in a separate operation. Also by raising the construction joint above the extrados, a curb was formed that precludes seepage to the face of the wall, if the waterproofing membrane fails. The wall was carried up to the underside of the sidewalk, with recesses to receive the sidewalk beams.

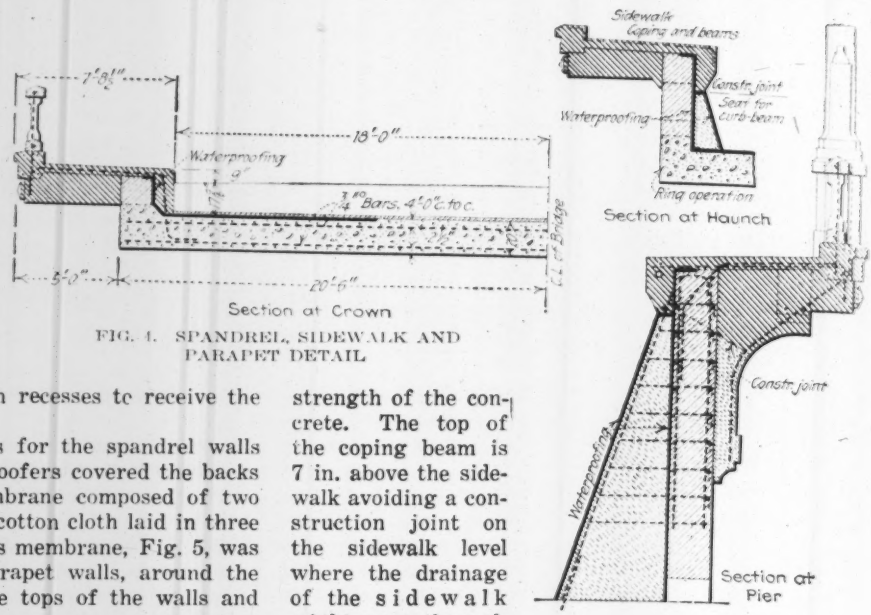


FIG. 4. SPANDREL, SIDEWALK AND PARAPET DETAIL

Immediately after the forms for the spandrel walls had been removed, the waterproofers covered the backs of the arch rings with a membrane composed of two plies of an asphaltic saturated cotton cloth laid in three swabbings of hot asphalt. This membrane, Fig. 5, was carried up the back of the parapet walls, around the buttresses and flashed over the tops of the walls and into the sidewalk beam recesses. This operation was followed immediately by a protective layer of 1:3 sand mortar 1½ in. thick over the backs of the arches to protect the membrane from being punctured in subsequent construction operations and in back filling.

FIG. 5. SOUTH ABUTMENT BUTTRESSES AND WATERPROOFING

The next concreting operation was the simultaneous pouring of the curb beam supported on the 6-in. ledge top of the wall counterfort, the sidewalk and the fascia coping beam. With this concrete operation, the waterproofing is positively secured and flashed, with no danger of being pulled away from the wall by settlement of the back fill or of water working behind the membrane, since it is completely protected by the curb beam. The heavy curb beam built with the sidewalk also gives a certain balance to the sidewalk overhang and furnishes a sort of lock giving added strength by the tensile strength of the concrete. The top of the coping beam is 7 in. above the sidewalk avoiding a construction joint on the sidewalk level where the drainage of the sidewalk might seep through to the face of the coping. The coping is reinforced to act as a beam carrying the balustrade and half the sidewalk load to the sidewalk cantilever beams. The sidewalk slab, therefore, is reinforced by light triangular mesh in the transverse direction extending to the edge of the curb. Vertical rods were embedded in the coping beam and projected the full height of the balustrade to hold the latter substantially to the coping.

Expansion joints were placed at the quarter points of each span, approximately at the point of contraflexure in the arch ring. To avoid the uncertain action of a sliding joint of any description, the superstructure at this point was cut clearly in two by a bulkhead. The sidewalk beam and counterfort, therefore, are built in two separate units and reinforced to take the separate end reactions. The joint was built up by multiple layers of tar paper. A steel plate covers it through the sidewalk and it is further protected from seepage by copper flashing embedded in the concrete.

In planning the equipment, the frequency of the floods suggested mobility and retreat and the high ground on the north bank of the river, with the protection afforded by the dike, offered the haven of safety.

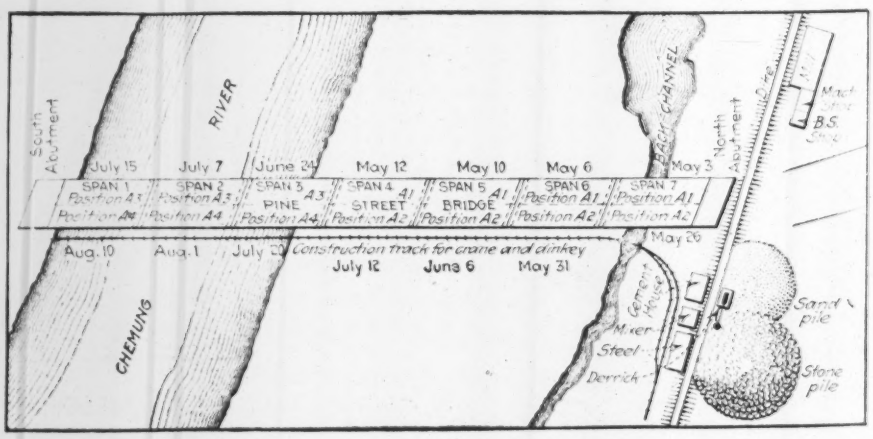


FIG. 6. PLANT LAYOUT AND PROGRESS SCHEDULE

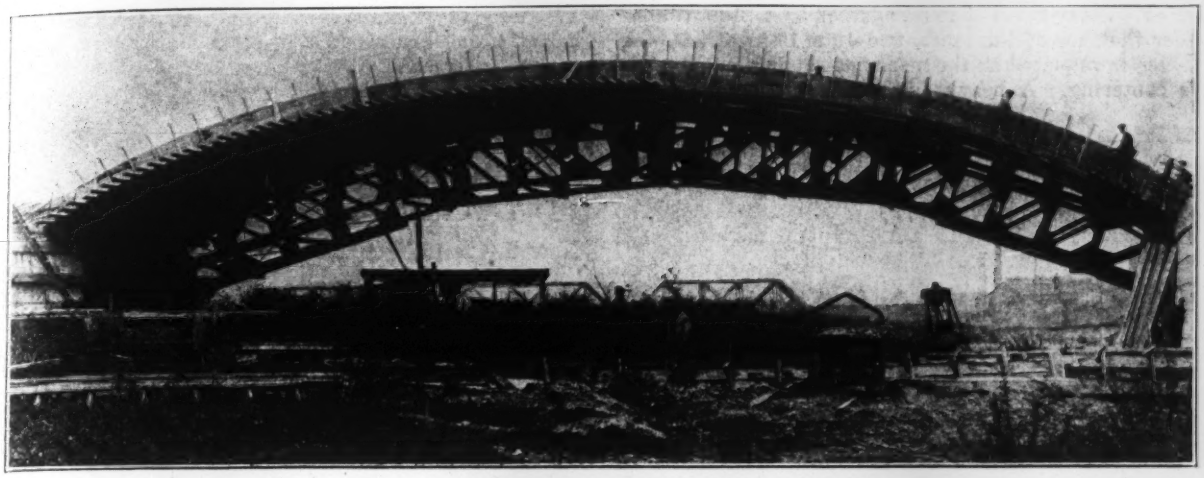


FIG. 8. CENTERS AND ARCH RING FORMS IN PLACE

Therefore the construction of the bridge was planned around a locomotive crane, with a 60-ft. boom, and a construction plant as indicated by Fig. 6. A derrick, having a 75-ft. mast and 70-ft. boom was placed within reach of the stock piles, the cement and steel store houses and the concrete mixing plant. The wooden forms were built near by so that they could also be handled by the derrick. These forms were built in heavy units, Fig. 7, so that they could be reused.

Work started on Oct. 5, 1920, excavating for the south abutment. Building and grading a ramp from the top of the bank the crane worked its way down to the river's edge, and thence across on tracks laid in the bed of river during low water, driving the sheeting and making the excavations for the river piers as it proceeded. Immediately after the excavation was completed the pile-driving equipment was lowered into the hole and the driving of the piles commenced. It was estimated that 15 piles could be driven in a working day and this progress was made in driving 633 piles in 42 working days. About two days were required to move the driver from pier to pier. The driving schedule was interrupted for a short period in the early part of November due to an unprecedented flood for this particular month. The specifications required eight blows of a No. 1 Vulcan steam hammer to 1 in. penetration and where driving was especially difficult twelve blows were given to secure depth. The average driven length of the piles was 12 ft.

Work on the piers followed the pile driving. The foundations for the river piers were poured before floods of any consequence occurred, but the pier shafts were completed between floods, with a very narrow margin of time in each operation. Work on the piers was advanced so that the superstructure could be started from the north end and be completed on the high ground during spring months to the river's edge before the June flood. Fortunately, due to the unusual drought this flood did not materialize but the work was developed accordingly to the predetermined plan which contemplated that high water would cause delay but would not cause serious damage to the work or plant.

Fig. 8 shows the structural steel centering. One unit, forming a half-width arch barrel, was composed of two ribs made up of four separate Pratt truss sections, with parallel top and bottom chords. These sections were made to conform to the approximate curve of arch by wedge-shaped diaphragms at the crown and quarter points of the truss. The true curve for the lagging was formed by wood shims of variable height, which raised to the proper level and inclination the 6 x 12-in. purlins set parallel with the skew axis of the arch. Over these purlins 4 x 10-in. longitudinal riders, 3 ft. 3 in. center to center, were warped to the true curve of the intrados and to them the 2 x 6-in. lagging, laid parallel to the skew axis, was nailed. The weight of one rib assembled was 9.2 tons which was easily handled by the crane, Fig. 9, to its position on the timber bent bolted to the piers.

This supporting bent was capped by a 10- x 10-in.

FIG. 7. BALUSTRADE FORM UNITS BEING PLACED

timber. Between the cap and another 10 x 10-in. timber under the shoe of the truss, two 10 x 10-in. x 4-ft. oak wedges were placed as the means of raising or lowering the centering. A heavy oak thrust block, cut to the

FIG. 9. DERRICK SETTING STEEL RIB FOR ARCH CENTER

skew angle of the bridge, was set back of the truss shoe to transfer the horizontal thrust to the piers. Rollers were placed between the two 10 x 10-in. timbers before the wedges were struck, on which the entire unit, truss, lagging and all, was jacked and rolled over to the second half of the arch ring.

The sequence of arch construction is shown in Fig. 6. The rings were poured in the order named and each one is a continuous operation, pouring alternately from either end. Including a 9-in. lift over the half area of the pier, there were 160 cu.yd. in each operation poured in eight hours with a one-yard mixer. The short time between arch ring operations was employed without reduction of force in the construction of the parapet walls, sidewalk and balustrade. When the last half of the arch ring was poured Aug. 10, the parapet walls were almost completed on all the spans and much of the sidewalk and railing was completed. In this manner operations were distributed over the entire work so that a maximum force could be economically employed up to the last three weeks. Remarkably fast work was done with the centers erection and concrete placing in the arches. Within one month after the arrival of the centers four halves of arches had been poured.

The bridge was planned and supervised by A. B. Cohen, consulting engineer, New York City. J. I. Bingham was resident engineer in field charge. The improvement was carried on through the office of W. O. Drake, Superintendent of Public Works, Corning, N. Y. Bush, Roberts & Schaefer Co., of New York, were the general contractors with J. E. Jones superintendent of construction. The piles were driven under separate contract by MacArthur Concrete Pile & Foundation Co. and the centers furnished by the Blaw-Knox Co.

Columns and Walls Lifted By Swelling Clay Under Floor

New Texas Church Built in Dry Year Damaged When Clay Enclosed by Foundation Walls Became Saturated

BY F. E. GIESECKE
Professor of Architectural Engineering, University of Texas, Austin

SHORTLY after construction of the University Baptist church in Austin, Tex., a change in the moisture content of a 6-ft. layer of clay under the building produced a vertical expansion of about 4 in. and thereby lifted and broke the concrete floor slab, lifted iron and wooden columns, with their superimposed loads, off the concrete piers originally supporting these columns, and lifted a brick wall together with a portion of its concrete foundation wall, after having overcome the tensile strength of the concrete foundation wall. The clay is decomposed Eagleford shale.

The building was erected in two installments; the first portion, which included the Sunday school department and the basement of the main building, was erected by Johnson & Chambers, of Austin, from April 1918, to January, 1919; the second portion, which completed the building, was erected by Hedrick Construction Co., of Houston, from August, 1920, to October, 1921. The architect was Albert Kelsey of Philadelphia;

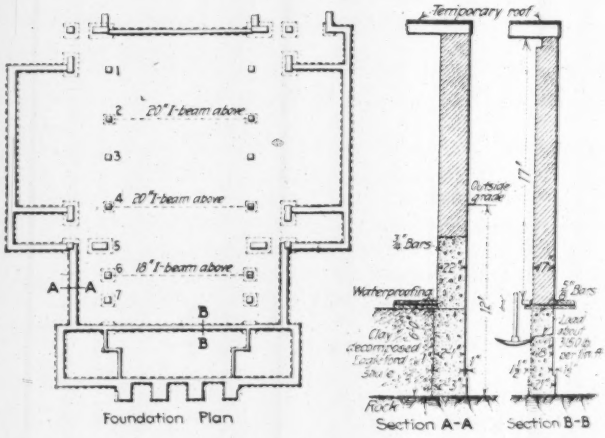


FIG. 1. PLAN OF DAMAGED CHURCH

the supervising architect of construction was Roy Thomas of Austin.

In Fig. 1, a plan of the basement of the main building, several walls are lettered for reference in the following description of the effect of the expansion of the clay. Fig. 3 shows the rainfall in Austin for 1917, 1918, and 1919; the first construction period of the building and the date when the failure of the concrete floor slab became noticeable are marked. As appears from this figure, the erection of the building followed a very dry year, the concrete floor slab was poured in July, when the ground was very dry, and the failure of the con-

FIG. 2. CRACKED WALL FOUNDATION

crete floor slab became noticeable in June of the following year after a long period of heavy rains.

The foundations of the building were designed, under the direction of the writer, to rest on rock and to exert a pressure of 40 lb. per sq.in. thereon. For this condition the walls A and B (Fig. 1) needed practically no projecting footings, and the contractors excavated the trenches for these walls accurately and poured the concrete into the trenches without the use of other forms. To provide the entire building with a waterproofing membrane, 3½-in. of concrete was laid over the entire floor, across the concrete footings for the columns and across the concrete foundation for the wall B.

After the concrete floor slab had been poured, a wet season set in. The clay under and around the building became as wet as it could possibly be, the elevation of the groundwater at the building was above the level of the basement floor, and the 6-ft. layer of clay, under the basement floor expanded vertically about 4 in. Horizontally it did not expand at all, because it was confined by the four exterior concrete walls, which did not crack. The result of the expansion of the clay was the bending and lifting of the concrete floor slab, and with it (since the lower portion of the concrete floor slab extended under the columns) the columns and the brick wall B.

All the columns and the entire area of the floor were lifted. At the exterior walls the floor sloped down, so that it was evident that either the foundations of all the walls and (to lesser extent) the column foundations were settling, or that the floor together with wall B and (to lesser extent) the columns were being raised up. The levels of the columns seemed to bear some relation to the loads on the columns, the most heavily loaded columns being lowest. Assuming the action to be one of lifting, the condition may be described by the statement that the most lightly loaded columns had lifted about 4 in., and the most heavily loaded columns about 1 in., the differences in lift being represented by bending and warping of the floor slab near the columns.

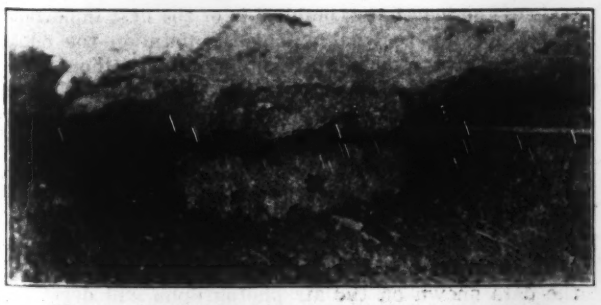


FIG. 4. COLUMN PIER LIFTED FROM ITS BASE

It took several months of investigation to prove definitely that the floor had been lifted up and that the foundations had not settled.

Column 1, a 6 x 6-in. wooden column, was lifted off its concrete pier several inches. The lifting of this column bulged the roof over it very noticeably. The foundation of wall B was cracked as Fig. 2 shows. This wall, weighing 3,150 lb. per linear foot, was lifted about ½ in. After the concrete slab had been cut on both sides, the wall settled back to its original position and closed the crack. Fig. 4 shows the concrete pier under column 7, which developed a crack about 2 in. wide just below the floor, apparently at a construction joint.

An effort to determine accurately the degree of contact between the wall footings and the foundation rock failed because the excavations made for that purpose without and within the building could not be cleared of water. However, it was possible to drive a ¼-in. rod 24 in. long between the foundation rock and the footing of wall A and it was possible to push a trowel up to its handle between the foundation rock and the footing of wall B. The question arises whether the wall footings were never in contact with the foundation rock or whether the clay in expanding gripped the two walls and lifted them.

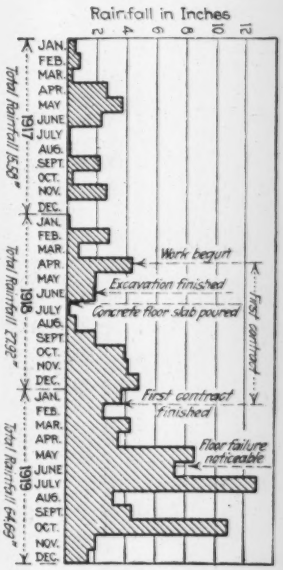


FIG. 3. LOW RAINFALL PRECEDING AND HIGH RAINFALL FOLLOWING CONSTRUCTION OF THE CHURCH

In this connection an experiment was made by filling a three-gang, 2-in. cube brass mold with compacted pulverized clay and allowing the clay to absorb water while the mold rested on a glass plate. The clay expanded vertically a little more than ¼ in. and horizontally to such an extent that the friction against the smooth brass mold was sufficient to lift the mold 0.049 in. off the glass plate. The clay in the mold was then dried, the middle mold emptied, and the space around the clay blocks in the outer molds filled with dry pulverized clay. When the clay was again allowed to absorb water, a similar expansion resulted as in the first experiment, and the brass mold was lifted 0.04 in. off the plate glass. By similar action the clay in contact with wall A could have lifted that wall slightly, and it seems, therefore, entirely possible that the wall A is no longer resting on the foundation rock, but that it is supported by the bond to the clay.

When funds had been secured to continue the erection of the building, the contractor, under the direction of the supervising architect, cut the concrete slab around the columns and on both sides of the wall B and allowed the columns and the wall to settle back to their original supports before proceeding with the erection of the superstructure.

Uses of Aerial Photographs in Map Making

Work Must Be Co-ordinated with Ground Surveys—Will Aid Completion of Topographic Map of U. S.

By Glenn S. Smith

Acting Chief Topographic Engineer, Topographic Branch, U. S. Geological Survey, Washington, D. C.

TWO articles have appeared in *Engineering News-Record* within the past few months on the use of aerial photographs in connection with mapping. The article appearing Oct. 13, 1921, p. 596, prepared from data supplied by Frederick E. Jones, of the American Air Service Corp., was very optimistic in tone as to the extent to which these photographs could be utilized, based apparently on theory rather than on any practical tests to which they had been subjected. On the other hand, the letter signed by P. J. Barry, Dominion Water Power Branch, Department Interior, Canada, in the issue of Nov. 17, 1921, p. 828, was very pessimistic and did not concede that there are any practical values to be obtained from aerial photographs. A more conservative position is taken by the U. S. Geological Survey in reference to the use of air photographs, based on the results obtained from their use in connection with several field surveys covering large areas.

PHOTOGRAPHS COMBINED TO FORM MOSAIC WITH TOPOGRAPHIC FEATURES INKED FOR TRANSFER TO FIELD SHEET

It is unfortunate that the word "mosaic-map" has been applied to a combination of photographic prints, as this is a misnomer and a better name would have been a "mosaic photograph" of the area. A map is the delineation of some portion of the earth's surface on which the geographical position of certain features is shown in the correct relative position. The so-called "mosaic map" is not a map in this sense, as the features shown on the combined prints are in no case in their correct relative position to all others shown on the mosaic.

Air photographs taken with the latest type camera by experienced airplane photographers contain valuable data which can be used to great advantage in the compilation of base maps when such data are properly controlled by means of ground surveys, such as triangulation or primary traverse. The use of air photographs in connection with the general mapping of the country is confined at present to maps not larger than 1:10,000, and wherever photographs are used in connection with engineering problems they are for the purpose of facilitating the study of these problems as a whole, and only in exceptional cases can they be used for working plans. It has been demonstrated that the data obtained from air photographs, when handled by experienced engineers or cartographic draftsmen familiar with the adjustments of ground survey data, are far more complete, and in most cases more accurate, than are obtained by means of the present methods employed in ground surveys. The wealth of information shown on the photographs and the availability of this information for frequent reference, when necessary, makes this method of securing survey data superior to the ground methods.

Errors in Ground and Air Work

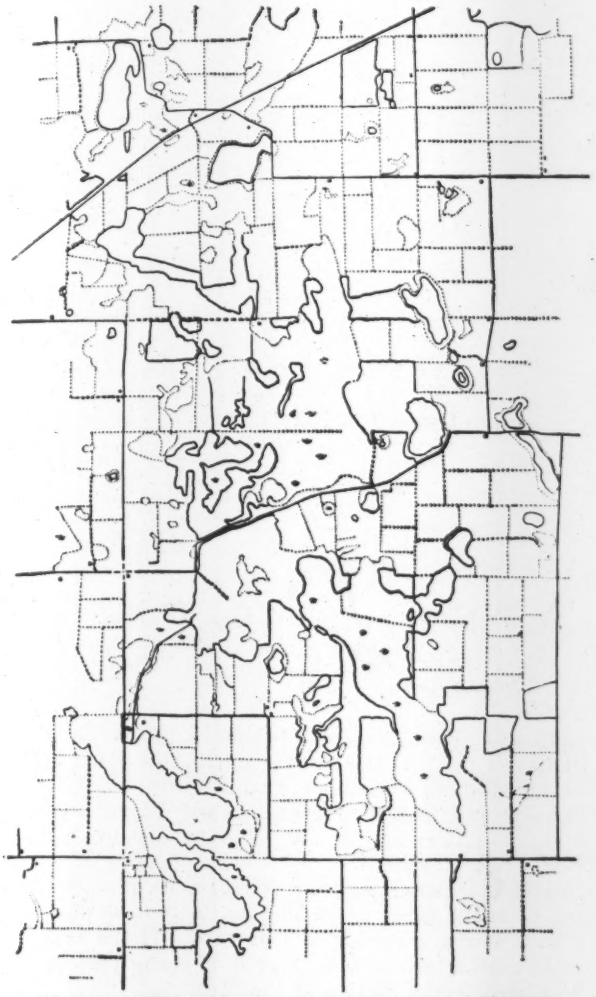
Any method employed in making ground surveys is subject to errors which may be caused by a gross error at one or more points, or may be an accumulation of several errors due to errors in the field or in computing or plotting the field notes in the office. All such errors must be corrected either by a resurvey or by arbitrary adjustments in the office, either being far from satisfactory. On the other hand, the errors in the air photographs due to distortion caused by the tilting of the ship (which can now be accurately determined by means of various devices), poor lenses, or by expansion or contraction of the paper used in making the prints, are all errors which can be located and can be adjusted in the office with a greater degree of accuracy than errors in ground surveys.

In considering the use of air photographs for supplying data for the compilation of maps, the question of the scale of the map to be compiled is of the first importance in considering to what extent the data on the photographs can be used in such compilations without introducing a source of error. If the standard map of the United States, on scale of 1 in. to the mile, is to be prepared, the errors appearing in the photographs due to distortions caused by poor lenses or the failure of the pilot to fly his ship on an even keel can be easily eliminated by means of ground control lines covering the area to be surveyed at intervals not to exceed 5 miles.

The amount of control necessary to adjust accurately the data shown on the air photographs will depend on the scale and the character of the country to be mapped.

and, as a rule, such control can be better planned after the country has been photographed and an examination of the resulting photographs made to determine which photographs or series of photographs in any flights are subject to adjustment. Control lines can then be run through such areas as are needed to meet the requirements for adjustments. In country of average relief, control lines or points, when plotted on the base or projection sheet, should not be farther apart than 5 in. *on the paper*, regardless of the scale of the map. In country other than average relief, control must be placed to meet the conditions that exist in the area under survey.

The methods of taking air photographs and the results obtained have not reached a point where they can be used for all classes of maps, but the practical demonstations which have been made within the past year by the Topographic Branch of the U. S. Geological Survey, have proved beyond doubt that this source of



IN BLEACHED MOSAIC ONLY INK LINES REMAIN

information will be extensively used in connection with the topographic mapping of the United States on a scale of 1 in. to 1 mile. This is especially true in connection with the survey of swamp areas lying on the coastal plain and in sections of the United States where there is little or no relief.

Within the last year the Topographic Branch in cooperation with the Air Service of the U. S. Army, has used the photographic data in connection with the survey of two large areas, one located in the vicinity of Schoolcraft, Mich., covering an area of 225 sq. miles, and the other of Bibb County, Ga., covering approximately 275 sq. miles. The Schoolcraft area is located in a Land Office-surveyed state, and there were available the Land Office survey land lines which could be used for the control of the data contained on the photographic prints.

In order to transfer the data supplied by the photographs to the field sheets, the land lines were laid down on the field sheets and were tied to primary control points which had also been previously established. Three or four photographs, such as the specimen shown, were joined together by overlap. On this small mosaic those features which it was desired to transfer to the field sheet were then inked in. The mosaic was then bleached to clear off all other details of the photographs. The resulting bleached photograph was then reduced by photography to the proper scale of the map, as given by the land lines. One of these reduced copies is shown. The wealth of detail carried by these field sheets is evident at a glance.

The photographic prints clearly showed the location of a large percentage of these land lines, which appeared on the prints either as fence lines or the limits of timber tracts or cultivated land, which enabled the engineer easily to locate on the photographs the land lines plotted on the base sheet. The data taken from the photographs, which consist of roads, houses, streams, timber line, etc., were transferred to the corresponding section on the base map. Any error in the photographs due to distortion was adjusted within and confined to each square mile. As these photographs were taken on a scale of approximately 4 in. to the mile, and the data reduced to 1 in. to 1 mile, any slight distortion or error that appeared in the photographs was eliminated by this great reduction.

In the case of Bibb County, Ga., it was necessary to run a network of ground control lines of primary traverse, by means of which the intersection of cross-roads, railway crossings, railway lines and other prominent ground features which appeared on the photographic prints were computed to obtain their geographic position and were then plotted on a base sheet as control points to which the data taken from the photographic prints were adjusted. In this map, the control points were in no case farther apart than 5 miles, and it was found that with the photographic prints on a scale of approximately 4 in. to 1 mile, when placed together by means of approximately 60 per cent overlap and reduced to 1 in. to the mile, the area to be adjusted between any two control points was well within the degree of accuracy required for a map on a scale of 1 in. to 1 mile. In every case the data taken from the photographs were used in the same manner as the same data would have been used if secured by means of plane-table traverse. Wherever an error was found it was adjusted between the control points. The amount of control necessary for the control of the data shown on the photographic prints depends entirely on the character of the terrain of the area under survey. If the relief is great the control lines or control points must be very much closer together than in a country of low relief.

Mr. Barry cites in his letter an example of distortion which could take place, but no experienced flier or photographer would bank his machine at such an angle

as to make it possible to secure a photograph distorted as shown by the diagram submitted by him.

Various devices are used to determine the position of the airships at the time each photograph is taken, and should the records for any photograph show that it was taken when the airship was in position similar to that described by Mr. Barry, that photograph would be discarded as one unfit for use and new photographs taken of the area, or ground methods substituted to secure the data required.

The value of aerial photographs in connection with various engineering activities is being appreciated more and more by engineers who recognize the proper method of using them to obtain the greatest amount of information. For example: The Reclamation Service of the Canadian Government is reported to have photographed approximately one million acres of land on the Carrot River between Manitoba and Saskatchewan, which is inaccessible on account of floods.

The engineers state that this photographic work does not supersede the ground surveys, but is used mainly for reconnaissance purposes, which indicates that they thoroughly understand the value of air photographs.

Too many fliers and photographers who are totally ignorant of the fundamental principles of accurate map making have made enthusiastic claims that air photographs will completely do away with the necessity of ground surveys. The public has been led to believe that the complete mapping of the United States could be executed in an amazingly short period and at a cost insignificant as compared to that which would be involved in preparing a map of the United States by ground surveys. The result is that the necessary mapping activities which are essential for the proper use of air photographs are being curtailed under the impression that the "mosaic" will replace the ground surveys. Air photographs are destined to play an important part in all mapping activities, and to a limited extent in the solving of certain engineering problems, but for general use, other than that of government map making, there must be greater facility for securing the use of privately owned airships manned by specially trained personnel in order to obtain photographs at a cost not to exceed that of obtaining the same data by ground methods before any practical value can result from them.

The development of airplane photography is in its infancy, but there is every indication that it will eventually become an important factor in connection with mapping activities and replace many of the ground methods now employed in securing map information, but before this can be accomplished there must be an immense amount of experimental work done with a view of perfecting the present methods of photographing from the air and also to reduce the cost of such work.

Cost of Burying Garbage of Baltimore

During the three months, September, October, and November, 1921, pending the disposal of the garbage of Baltimore, Md., under contract by the Sanitary Reduction Co., a total of 18,315 cu.yd. of garbage were buried at the old piggery farm. The cost was $1.225 per yard, including unloading and burial only, and about $1.68 taking into account the cost of equipment, and other factors. The methods employed were described in *Engineering News-Record*, Oct. 27, 1921, p. 694. The work was done under the direction of A. E. Christhilf, highways engineer of Baltimore.

Cold Weather Concreting Methods and Equipment

Plant for Heating Materials—Methods of Placing Canvas Housing—Location of Salamanders—Fire Protection

PROTECTION of concrete building work from frost is completely secured by heating the materials before mixing, covering the green concrete tightly with canvas and placing salamanders so as to cause a circulation of heat around the concrete. No other resorts are necessary for safe concrete construction in winter. The procedure is not difficult nor complex but it has to be conducted with attention to detail. The details as they have been worked out by the Turner Construction Co., New York, on many concrete building operations are given in this article.

Warm concrete is the first essential for safety from freezing in winter construction. The most satisfactory

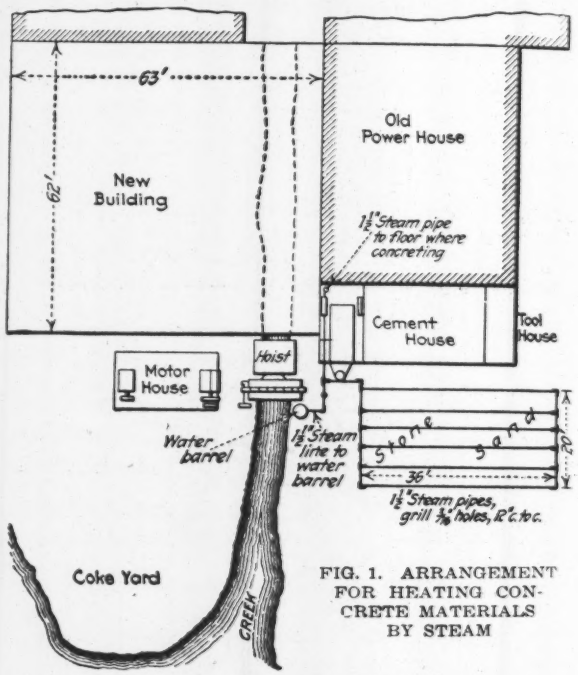


FIG. 1. ARRANGEMENT FOR HEATING CONCRETE MATERIALS BY STEAM

method of heating sand and pebbles is by a 1½-in. steam line run from the boiler to the stock piles where a grill of 1½-in. pipes covers an area slightly smaller than the area required for storage. These pipes should be 4 ft. on centers and should be perforated by ⅜-in. or ½-in. holes staggered on 1-ft. 6-in. centers, or, where trouble is experienced from large grains of sand blocking up round holes, by cutting notches in the pipe with a hack saw at intervals of 1 or 1½ ft. If the sand and gravel are stored in bins, a grill of steam pipes should be placed in the bottom of the bins.

In case the stock pile will not be constant enough to warrant a grill on the ground, insert in the steam main three connections controlled by valves and attach to each a length of steam hose on the end of which is fastened 6 ft. of perforated pipe, with one end closed and drawn to a point. Two of these pipes should be driven into the gravel pile and one into the sand pile at places where the carts or barrows are loaded.

A 1½-in. steam line controlled by a valve conveniently

placed at the mixer, should be run from the boiler to the water barrel with the pipe extending down into the barrel to about 2 in. from the bottom in order to force live steam into the water. Also a 1½-in. line should be run up on the concrete hoist and a suitable valve and connection supplied at each floor level to provide for the attachment of steam hose for cleansing ice and snow from the forms and reinforcement.

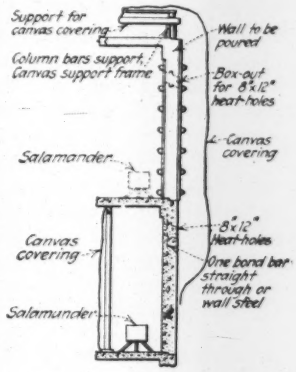


FIG. 2. HOUSING AND HEATING COLUMNS AND FLOORS

For a large operation, a 50-hp. boiler carrying from 50 to 60 lb. of steam is required to furnish heat and if steam is used for cleaning snow and ice from the forms in addition to heating aggregates and water, a 50-hp. boiler is the smallest practicable size for even a comparatively small job. On jobs of not more than 5,000 sq.ft. area on one floor, an 18 to 25-hp. boiler will give good results.

Housing and Keeping Placed Concrete Warm

Support the canvas on wooden frames resting on the column reinforcement about 18 in. above the floor and hang curtains from the exterior columns. The curtains should be carefully lashed to the underside of the floor below, care being taken to have the canvas some distance from the exterior forms so as to provide a circulation of heat (Fig. 2). Then a curtain hung across the width of the building under the forms will shut off the section to be concreted.

Enough salamanders should be provided to maintain a temperature of from 60 deg. to 80 deg. F. in this section. This will usually require one salamander to every 300 sq.ft. of floor area. The side curtains should be in place and the fires started in the salamanders as soon as, or before, concreting is started, and in extremely cold weather the curtains should be in place and the fires burning for several hours before beginning to deposit concrete. As soon as one bay of the slab is concreted it should be covered and in general the entire work should be closely followed with the protection.

Where the bays are not over 20 ft. square, provide one heat-hole about 8 x 12 in. through the slab so that circulation of heat may be maintained over the slab. In larger bays, provide a heat-hole for each 300 ft. of floor area. These heat-holes should have bevelled sides so as to make the filling plug of concrete perfectly secure (Fig. 3). When the canvas is removed the heat-hole should be covered with boards.

It is the best practice in winter work to concrete the columns at the same time as the floor and in this case great care should be taken to tamp the columns to prevent shrinkage cracks between the slab and the column head. Tamping sticks should be left in the head of the column and for several hours after the floor is concreted tamping of the columns should be continued. If the columns are concreted the day previous to the floor slab the side protection should be in place, floor forms made tight and the tops of the columns covered to prevent the column heads from freezing.

The most difficult places to protect from frost are the bases of exterior columns. It is frequently found that with a temperature of 80 deg. F. near the under side of the slab, a temperature below freezing will be found near the bases of the exterior columns. Hence, in extremely cold weather it is necessary to place a salamander on two sides of every exterior column. The bottoms of the columns may be further protected by packing the forms with marsh hay, or other suitable material. When unusual speed is required, or in extremely cold weather, it will be necessary to curtain the floor below and place salamanders around the bases of exterior columns.

This method of protection is also necessary when monolithic walls are carried up with the building as it is practically impossible to protect them from the cold unless heat is supplied from the story below. If the walls are blank it will be necessary to provide openings in the forms to allow circulation of heat to the outside of the exterior walls. These openings should be about

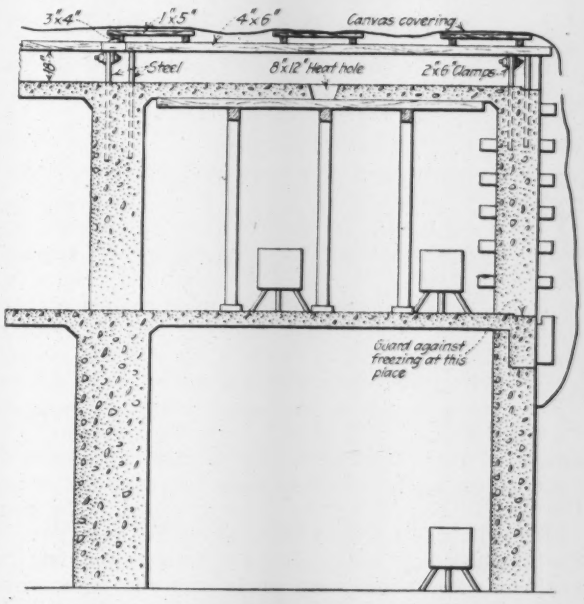


FIG. 3. HOUSING AND HEATING EXTERIOR WALLS

8 x 12 in. and should be bevelled down and upward so as to prevent water from entering the building when the holes are plugged (Fig. 3). There should be two such heat openings in each panel between columns.

It is important that the man tending the salamanders be carefully instructed as to the proper method of firing and as to the precautions necessary to prevent the canvas and forms from catching fire. Best results in firing will be accomplished if a small amount of fuel is applied frequently thus obtaining a maximum of heat with a minimum of smoke. The average laborer has a tendency to apply a large quantity of fuel at infrequent intervals as this tends to lighten his work.

As a protection against fire, several barrels of water should always be standing on each floor where salamanders are burning. They should be inspected frequently to see that the water has not leaked out or frozen. Care must be used to see that the canvas is securely fastened in order to prevent it from blowing

against the salamanders as experience has shown that this is a source of danger from fire.

During the entire time that protection of concrete is in progress a detailed temperature record should be kept in permanent form showing the date and hour, outside temperature, temperature at the bottoms of columns, temperature at the under sides of the slab, under the canvas over the slab, and the temperature of the concrete as it is placed in the forms. Temperatures should be taken at the bottoms of a number of exterior columns and especially at those columns on the windward side of the building.

The superintendent in charge of winter construction work should make a personal inspection of the job before leaving at night in order to see that all the precautions are being carried out. He should also make occasional visits to the work in the course of the night in order to see that all the men are carrying out their various duties.

Special Cast-Iron Pipe Used for Whittier Water-Works

Higher Tensile Strength and Lighter Pipe Saves $13,000 in Cost at Foundry and $20,000 in Freight on 305 Tons

By E. A. Rowe
Engineering Offices of J. B. Lippincott, Los Angeles, Cal.

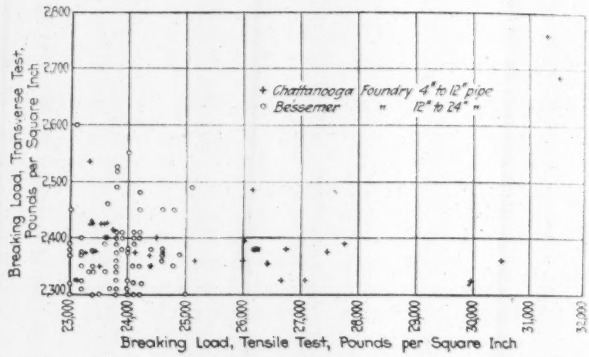
THE city of Whittier, Cal., has recently completed the construction of improvements to its domestic water system involving the expenditure of approximately $400,000. The work involved the driving of wells, installation of additional pumping equipment, construction of a 7,000,000-gal. reservoir and the replacement and enlargement of the pipe distribution system. These works were constructed with money received from a bond issue, based on engineers' estimates, made in June and July of 1919, shortly after the signing of the armistice. There had been a slight drop in the price of water-works materials immediately following the armistice and further reductions were expected. The estimates were based on the prevailing market quotations at the time they were made. However, between the time the engineer's estimates were made and the time when the bonds were voted, sold, and the money made available for construction work, there was a heavy advance in most of the materials entering into this work. Cast-iron pipe which prior to the war was laid down in Los Angeles for $28 per ton rose to $95.

About 50 per cent of the cost was for the pipe to be used in the distribution system. The price of this material advanced approximately $18 a ton between the time the estimates were made and the bids were opened. Meanwhile freight charges had also advanced. The advance in pipe cost alone increased the estimated total cost approximately $50,000. It was, therefore, apparent that if the work was to be done as outlined and within the limits of the bond issue, great economy would have to be exercised. The largest saving accomplished was in the cast-iron pipe.

The original specifications for the cast-iron pipe were those adopted by the American Water Works Association. When the bids were opened it was found that two large manufacturers had not only bid on the specifications submitted but also on a special pipe to be made of cast iron having a higher tensile strength than the ordinary standard metal, resulting in a pipe lighter in dimensions and weight. The engineers, after careful inquiry of the experience of water-works superintendents and engineers of cities where such pipe had been used, decided to purchase the high tensile pipe for this order, provided it would be manufactured under the city's specifications. In submitting their bid for the high tensile pipe the manufacturers stated that this higher strength would be secured by the use of higher grade ores in the manufacture of the iron. In preparing the specifications the Fanning formula was used.

$$t = \frac{(p + 100)\,d}{0.4s.} + 0.333\left(1 - \frac{d}{100}\right),$$

in which t equals the thickness in inches; d equals the diameter in inches; s equals the ultimate tensile strength of the cast iron; p equals the working pressure in pounds per square inch; $(p + 100)$ equals the working pressure + 100 lb. per square inch for water hammer. When this allowance is made for water hammer the factor of safety equals 5. Using this formula it was found that pipe of the dimensions of Class A (American



BREAKING LOADS UNDER TENSILE AND TRANSVERSE TESTS OF 200 SPECIMENS OF CAST-IRON PIPE

Water Works Association) would serve for Class B service when s in the above formula was 23,000 lb. per square inch. The American Water Works Association specifications called for an ultimate tensile strength of 20,000 lb. per square inch. It was decided to specify an ultimate tensile strength of 23,000 lb. per square inch and use the dimensions specified for Class A pipe for pipes to be subjected to Class B pressure and to use Class B pipe dimensions for pipe to be subjected to Class C pressures. By so doing it would not be necessary for the foundry to change its patterns and moulds.

Cast iron can be made to have a tensile strength of 23,000 lb. per square inch from the same pig used when making pipe in conformity with the American Water Works Association specifications of 20,000 lb. per square inch by a more rapid cooling of the finished pipe. However, by so doing the resulting pipe is hard, dense and brittle. In order to protect the city against such practice it was decided to change the specifications for the transverse loading and deflection to agree with the new tensile strength.

The standards of the American Water Works Association provide that the transverse test shall be made on bars 26 in. long, by 2 in. wide and 1 in. thick, which when placed flatwise upon supports 24 in. apart and loaded in the center shall support a load of 2,000 lb. and show a deflection of not less than 0.30 in. before break-

ing. Careful search of engineering literature was made to find some relation between the tensile strength of tensile bar specimens and the load supported by bars under the transverse test. Little definite information on the subject could be found. The two large waterworks associations have committees appointed to revise the specifications for cast-iron pipe and they are now engaged in research to settle just this point. At the time our specifications were drawn these committees had no data available for our guidance. Authorities seem to agree that the size of the test bar used in transverse tests has an effect upon the results. In the absence of definite information on the subject it was decided to specify that the breaking load on a transverse bar specimen should be 2,300 lb.—10 per cent of the ultimate tensile strength of the metal. This is in line with the standards of the American Water Works Association which require transverse breaking load of 2,000 lb. and an ultimate tensile strength of 20,000 lb.

Specifications Adopted

The deflection specified was computed in accordance with the tentative specifications prepared by the joint committee of the New England and American Water Works Associations. These specifications, while published, have not yet been adopted by the societies. They read as follows:

> The bars when placed flatwise upon supports 24 in. apart and loaded in the center, shall support a load of 2,000 lb. and show a deflection of not less than 0.32 in. before breaking, and an increase in deflection of not less than 0.03 in. for each 200 lb. of ultimate breaking load in excess of 2,000 pounds.

Computed on this basis, transverse bars supporting a load of 2,300 lb. should show a deflection of not less than 0.36 in. The specifications when finally prepared were identical with those of the American Water Works Association with the exception that the dimensions and weights for Class B service corresponded to their standards for Class A service. Paragraph 9 of the standard specifications of the American Water Works Association was changed to read as follows:

> Specimen bars of the metal used, each being 26 in. long by 2 in. wide and 1 in. thick, shall be made without charge as often as the engineer may direct, and in default of definite instructions, the contractor shall make and test at least one bar from each heat or run of metal. The bars when placed flatwise upon supports 24 in. apart, and loaded in the center, shall support a load of 2,300 lb and show a deflection of not less than 0.36 in. before breaking, and if desired, tensile bars shall be made which will show a breaking point of not less than 23,000 lb. per square inch.

When the specifications were finally prepared the contract was submitted to the local representative of the successful bidder who signed the contract for the manufacturer. When they were forwarded to the home office of the manufacturer, their engineers took exception to the specifications in regard to the deflection specified, it being their contention that there was no engineering authority available for such a specification, and that in order to meet the deflection requirements it would be necessary to run the tensile strength to points higher than 23,000 lb., which they claimed would result in a hard pipe, difficult to tap. It was presumed that they would accomplish this by a more rapid cooling of the pipe. The specifications as prepared were probably defective in that they did not specify an increase in the transverse breaking load with an increase in the ultimate tensile strength. However, the city was protected against hard pipe by paragraph 8 of the American Water Works standards which contain the following clause: "The metal of the casting shall be strong, tough, and of open grain and soft enough to satisfactorily admit of drilling and cutting."

The pipe as delivered to the city was found to be as soft and as easy to work as standard pipe. In order to determine if possible whether or not there was any relation between the strength of the bars under transverse loading and the ultimate tensile strength, the city employed the Pittsburgh Testing Laboratories as their inspectors at the foundry, and had some 200 tensile and transverse tests made for each run of the metal. The results of these tests are shown by the accompanying diagram. It is apparent that there is no relation between the transverse and the tensile tests as shown by these reports. The foundries had considerable difficulty in making pipe to meet these specifications. Inspection reports showed that about 38½ per cent of the pipe was rejected at the foundry. No doubt a large part of this trouble was due to the unsatisfactory labor obtainable at the foundries at that time.

The pipe was shipped by rail from the Birmingham district to Mobile and thence by water to the docks at San Pedro, from which point it was trucked directly to the streets in which it was to be laid. Inspection at the San Pedro docks showed that a large quantity of the pipe had fine hair cracks at the spigot end. However, pipe manufactured in accordance with the American Water Works Association standard and shipped on the same boat showed the same cracking. It is believed that these cracks were caused by rough handling at the docks. The city and the pipe manufacturers had no control over the handling by the ship company. They seemed to prefer paying for damaged pipe rather than take a little more time in loading and unloading.

Economies Effected

The pipe has all been laid. It was necessary to remove several joints when put under pressure but inspection showed that in every case the defect was evidently due to an old crack which had escaped the inspector before laying. No evidence of breaking has developed which is directly chargeable to a weakness in the metal.

The difference in weight between standard pipe and the special pipe for the entire order amounted to approximately 305 tons. The saving in the cost of the pipe itself at the foundry amounted to $13,000 and in freight about $20,000. The rail freight rate from the Birmingham district to Whittier was $30 a ton. The regular line steamship company's rate, including rail rate from Birmingham to Mobile, was approximately $24 a ton. The city's engineers, however, by pooling orders for other cities in California with the Whittier pipe, to make an entire ship load, were successful in securing a rate of $18.50 from Birmingham to San Pedro. The entire work was accomplished without additional bond issues at a cost of some $30,000, over the engineer's estimate, which was met by a slight increase in the water rates. The plans, estimates and specifications were prepared by the engineering offices of J. B. Lippincott, Los Angeles, who also supervised the construction work. The pipe was manufactured by the United States Cast Iron Pipe & Foundry Company.

Why the Joint Commission Favors The St. Lawrence Waterway

Summary of Conclusions of the Report Discusses Navigation Possibilities, Economics and Engineering Features

ON JAN. 6, 1922, the International Joint Commission submitted to the Secretary of State its report on the proposed navigation and power development of the St. Lawrence River, a matter referred to the commission by the governments of the United States and Canada, Jan. 21, 1920. That report was transmitted by the President to Congress, Jan. 16, and was referred by the Senate to the Committee on Foreign Relations and by the House to the Committee on Interstate and Foreign Relations and, in regard to bond issues, to the Committee on Ways and Means. The report in full is being printed as Senate Document No. 114, and will make with maps and appendices several volumes. The final recommendations of the Commission were given in *Engineering News-Record*, Jan. 19, 1922, p. 128. The summary of conclusions on which these recommendations were based is as follows:

Navigation Possibilities

To sum up as briefly as possible its conclusions in the matter of the proposed improvement of the St. Lawrence River between Lake Ontario and Montreal, the commission finds nothing in the evidence to warrant the belief that ocean-going vessels of suitable draft could not safely navigate the waters in question as well as the entire waterway from the Gulf of St. Lawrence to the head of the Great Lakes, or that such vessels would hesitate to do so if cargoes were available.

It finds that of the various alternative routes mentioned from the interior to the seaboard, none offers advantages comparable with those of the natural route by way of the St. Lawrence.

As to the economic practicability of the waterway, the commission finds that, without considering the probability of new traffic created by the opening of a water route to the seaboard, there exists to-day, between the region economically tributary to the Great Lakes and overseas points as well as between the same region and the Atlantic and Pacific seaboards, a volume of outbound and inbound trade that might reasonably be expected to seek this route sufficient to justify the expense involved in its improvement.

It finds that, as between the American and Canadian sides of the tributary area, the former contributes very much the larger share of this foreign and coastwise trade, and in all probability will continue to do so for many years to come. The benefits to be derived from the opening of a water route to the sea will therefore accrue in much larger measure to American than to Canadian interests, though it is reasonable to assume that eventually the advantages may be more evenly distributed.

It finds that the existing means of transportation between the tributary area in the United States and the seaboard are altogether inadequate, that the railroads have not kept pace with the needs of the country, but that this does not apply to the Canadian side of the area, where railway development is still in advance of population and production.

While the commission is conscious of the fact that war conditions had something to do with the dislocation of railway traffic on the United States side of the boundary, and that various other factors must be taken into account, such as the congestion of traffic at certain critical points between the West and the Atlantic seaboard commonly referred to as "bottle-necks," and the abnormal demand for cars at certain times of the year to carry the peak load of the harvest, it is convinced that the fundamental difficulty lies rather in the phenomenal growth of population and industry throughout the middle western and western States, a growth which the railroads have failed to keep pace with.

The solution of the problem, in the opinion of the commission, lies in the utilization of every practicable means of communication, and particularly of the wonderful natural waterway extending from the Atlantic into the very heart of the continent, together with the development of such a system of co-operation between railways and waterways as would at one and the same time bring the load the railways have to carry within practicable limits, and give the West an additional route for its foreign and coastwise trade.

The conclusion is obvious that, if countries that had for the most part to import their raw materials from abroad were able to build up a great foreign trade because of their ready access to the sea, the region economically tributary to the Great Lakes, with its limitless resources, its raw materials within easy reach, its facilities for industrial expansion, can hardly fail to become an even greater factor in the world's markets than it is to-day, if given a practicable and efficient water route to the sea.

Of scarcely less importance is the linking up of land and water routes. Here also the experience of Europe is illuminating. Belgium and England are the most densely populated portions of Europe, and both are pre-eminently industrial nations. Each possesses a network of railways reaching into every corner of the country, yet each is today, despite its very short rail haul to tidewater, finding it necessary, in order to give adequate service to congested areas, to link up the railways and the highways with the inland waterways. Despite the difference in area between these countries and the rigion tributary to the Great Lakes, transportation conditions are not altogether dissimilar, particularly in the more congested areas of the Middle West. One finds in such a district as that around the south shore of Lake Michigan much the same conditions of a rapidly increasing concentration of population and industry, with a corresponding concentration of rail lines, that is so noticeable in England and Belgium. And similar conditions are quite evidently developing in the territory immediately tributary to Detroit, Cleveland, and other middle-western cities. When these cities and their tributary territory are given access to the sea, they will find it necessary, in order to secure the maximum benefits from the new route, to co-ordinate their railways and highways with the great waterway that will be common to them all. The advantages of co-operation will be found as real in this case as in Europe, although the remedy may be somewhat different in character.

An example on this continent of the effective co-ordination of rail and water services is found in the Canadian Pacific Ry., which, in conjunction with its rail system extending from ocean to ocean, maintains lines of steamers not only on the Atlantic and the Pacific but also on the Great Lakes and the inland waters of British Columbia.

Distribution of Cost

The whole question of the distribution of cost has given the commission some concern. If the area to be benefited were all in one country the problem of financing the improvement would be a comparatively simple one, but as the matter stands the situation is complicated not merely by the fact that two neighboring countries are joining in the project, but that these countries are unequal in population, unequal in wealth, unequal in their ability to make effective use of the waterway. That is the situation today, but it does not necessarily follow that it will always be the situation. As the years go by the relative position of the two countries will doubtless change, and the disproportion between their population, wealth, and commerce may gradually diminish. In the meantime the fair and reasonable plan appears to be to divide the cost in proportion to the benefits each receives.

Objection may be made that the proposed principle of dividing the cost in proportion to the benefits each country derives from the improvement could hardly be put into effect until the works had been completed and in operation for a sufficient period to secure reliable data on the subject. For the intervening period, however, the commission believes that there are already available authoritative statistics on

which to base a tentative decision as to the interest each country is likely to have in the waterway.

Another factor in the situation that should not be lost sight of is the peculiar relationship to the proposed improvement of the New Welland Ship Canal, a portion of which is now under construction. As pointed out in an earlier part of this report, the completion of the Welland Ship Canal and the adoption and completion of the St. Lawrence improvement would remove the only barrier to the creation of a deep-water route from the head of the lakes to the sea. This would give at least 25 ft. navigation from the sea up to the Detroit River, with a present minimum of about 20 ft. above Lake Erie. Although entirely outside the strict terms of the reference submitted to it by the two governments, the commission has been impressed by the fact that the New Welland Ship Canal is such an integral part of the waterway, and is so inseparably interwoven with the project under immediate consideration, that it should properly be considered as a part of the whole scheme and the expense of its construction should be apportioned between the two governments upon the same basis as the works recommended for the upper St. Lawrence.

In other words, each country should be debited with its share of the entire cost of all works necessary for navigation, including the cost of the Welland Ship Canal, based upon the proportion the cargo tonnage carried to and from its own ports by way of the St. Lawrence bears to the entire tonnage by the same route. The ratio to be charged to each obviously would require to be readjusted periodically.

Water Power

In regard to the water-power side of the question, by the language of the treaty as well as the obvious intention of the reference, water power must be regarded as subsidiary to navigation. Statements were repeatedly made during the hearings to the effect that while the movement for improving the St. Lawrence was nominally in the interests of navigation, it was really being engineered by water-power interests to serve their own ends. The commission is confident that there is no justification whatever for these assertions. As a matter of fact, as already stated, very little testimony of any kind was offered at the hearings upon the power side of the question, public attention being apparently centered on the economic practicability of the undertaking as a navigation route.

For the purposes of the conclusions, recommendations, and answers to questions, "navigation works" shall be deemed to mean and include all works of every kind and description required for the proposed improvement of the St. Lawrence between Montreal and Lake Ontario other than and except superstructures, machinery, plant, and equipment for the development and utilization of power in connection with such improvement; and "power works" shall be deemed to mean and include all superstructures and all machinery, plant, and equipment required for the development and utilization of power in connection with the said improvement.

In apportioning between the two countries the water power capable of development in the international section of the St. Lawrence, each country should be charged with such quantities of power as are set apart to meet the requirements of existing plants.

In regard to the distribution between the two countries of the cost of power works, the commission is of the opinion that as each country will be entitled to half the available power in the international section of the river, the cost of the works necessary solely for the development of that power should be borne equally by each country. It is further of the opinion that the cost of navigation works required for the combined use of navigation and power over and above the cost of works necessary for navigation alone should be apportioned equally between the two countries.

As elsewhere noted, it was repeatedly stated by those who appeared before the commission that the water power developed on the St. Lawrence would be sufficiently valuable to carry a considerable proportion, if not the whole, of the cost of the undertaking both for navigation and power. The commission desires to emphasize the point that if this prediction should prove well founded, nothing in the commission's conclusions and recommendations as embodied in this report need conflict with the charging to water power by either country of any proportion of its share of the entire cost that may eventually be found desirable.

In regard to the method of control, the commission is conscious of the fact that the peculiar character of the St. Lawrence, partly international and partly national, creates an unusual situation, and it believes that, in order to combine the fullest possible liberty of action on the part of each country in its own territory, with the efficient co-ordination of the several parts of the completed improvement, all navigation works lying wholly within one country and capable of economic and efficient administration as complete and independent units, should be maintained and operated by the country in which they are located; that navigation works not lying wholly within one country and not capable of economic and efficient administration as complete and independent units, should be maintained and operated by an international board on which each country would have equal representation; and that this board should also have the right of inspection of navigation works lying wholly within one country, for the purpose of insuring economy and efficiency. The commission is further of the opinion that all power works should be built, maintained, and operated by the country in which they are located.

An important result of the proposed improvement, if carried out, will be the extent of damage resulting from flowage due to the higher levels maintained in the St. Lawrence. This damage is estimated by the engineering board at about $6,000,000. The commission is of the opinion that there should be an exhaustive investigation of the extent and character of the damage as soon as the plan of development has been finally accepted.

Finally, the commission is strongly of the opinion that the subject matter of this investigation is one of such extraordinary importance to the people of the two countries, and involves engineering problems of such magnitude and diversity, that no effort should be spared to secure a plan which will beyond all reasonable doubt obtain from the upper St. Lawrence its maximum efficiency in navigation and power. To this end the commission believes that, before any particular scheme is finally adopted, all the available engineering data, including the report and plans of the engineering board and all comments thereon or alternative plans, should be referred to a special technical board for careful consideration and report.

Distinguishing Long-Leaf Pine From Short-Leaf by the Pith

LONG-LEAF pine has a large pith, usually over 0.1 in. in diameter, while short-leaf has a pith usually the size of the lead in a lead pencil. Occasionally a vigorous first year's growth may unduly increase the size of the short-leaf and loblolly pine, in which case positive identification may be made by measurement of the pith diameter and comparing it with the second annual ring. The Forest Products Laboratory has formulated a diagram on which these two diameters may be plotted. If the point falls above the diagonal line the specimen is long-leaf; if below it is short-leaf, loblolly or some other of the minor southern pines. The vigor of a tree at the time the pith is formed is indicated by the diameter of the second annual ring. Therefore, where the pith in loblolly is over 0.1 in. in diameter, the diameter of the second annual ring is comparatively large.

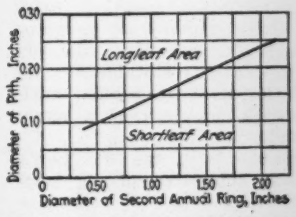


CHART TO DISTINGUISH LONG-LEAF FROM SHORT-LEAF BY RELATION OF PITH DIAMETER TO THAT OF SECOND ANNUAL RING

Road Builders' Problems Discussed at Convention

Abstracts of Some of the Papers Presented at the Nineteenth Annual Meeting of the American Road Builders' Association, Chicago, Jan. 16-20, 1921

North Carolina's Sub-Grade Roads

By Charles M. Upham
State Highway Engineer of North Carolina

NORTH CAROLINA now has a bond issue of $50,000,000 provided for the "purchase" of roads. It is the business of the State Highway Commission to purchase for the taxpayers of the state, road improvements which will serve the most people of the state and do the greatest economic good. For some time, many of the Southern states have been constructing sand-clay and top-soil highways, which, in reality, are sub-grades which at some later period will be covered by a roadway of a higher type. The roads of this type have been found satisfactory for many seasons of the year, and, in a degree, solve the construction of a large road mileage at a moderate cost.

Roads of this type are called "progressive type" roads. They are roads for which grading has been done in the ordinary manner, satisfactory drainage structures constructed and a subgrade of selected material built. This sand-clay or top-soil road or selected sub-grade, can be maintained at a moderate cost, and with moderate traffic is satisfactory for the greater period of the year. This is a progressive road because its construction can be added to, and advantage taken of all the previous steps, and a hard surface pavement constructed without loss of any of the previous steps in construction.

This sub-grade highway may be still further improved by constructing into the earth roads a single layer of stone which, after receiving a bituminous treatment, becomes an integral part of the earth road, and also affords for the bituminous material, a stone surface which will not dust up and allow the bituminous mat to peel from the surface. Upon this reinforced or armored subgrade highway can be constructed practically any hard surface type which may at some future time be required. In the meantime, a roadway capable of carrying moderate traffic at a reasonable maintenance cost is provided. It is doubtful if this treatment of subgrade highways would be satisfactory in the northern states, where there is excessive frost.

Notes on Brick Paving Practice

By W. W. Horner
Chief Engineer, Sewers and Paving, St. Louis, Mo.

FOLLOWING the recent reduction in paving brick varieties from 66 to 11 there remain as accepted standards three depths of brick—3, 3½ and 4 in.—and two widths—4 and 3½ in. The 4-in. depth is suitable for the heaviest traffic; the 3½-in. depth for moderate traffic; while the justification of the 3-in. depth, in spite of a slight saving in first cost, is questioned.

Repressed brick were eliminated from the St. Louis, (Mo.,) specifications in 1914, and side wire-cut lug brick have been used exclusively since that date.

Of the three types of bedding—plain sand, sand-cement and wet concrete (monolithic)—the writer considers the sand-cement mixture the most valuable in brick paving, regardless of the kind of filler used. Opinion seems to be about equally divided in the choice of filler as between cement grout, bituminous, or bituminous mastic. Where the brick is laid on a strong concrete foundation supported by a well-drained soil, the writer invariably prefers the cement grout as giving to the wearing surface a slab strength over small areas which is of value. If on flexible foundations or on clay soil subject to frost and heaving, a bituminous type of filler is probably a safer choice. When properly handled it is somewhat easier to secure good penetration with a bituminous filler than with cement grout. It has been argued that this ease of penetration with bituminous fillers justifies the omission of lugs, but an examination of recent pavements around the country and reports from engineers in the technical press do not bear out this contention.

The writer believes that the lugs heretofore used on both wire-cut and repressed brick are somewhat larger than necessary for this purpose, and that in the case of the bituminous filler a ½-in. lug will be satisfactory.

It seems advisable to raise the question whether efforts to reduce the cost of brick pavement in some cases are not carrying us into a design that is economically unsound, and whether the ultimate waste in pavement failures on this account may not be far greater than the waste we have been attempting to eliminate in the standardization of brick. The writer believes that the consumer, in this case the engineering profession, should seriously consider whether conservative specifications such as those of the American Society for Municipal Improvements, should not be more strictly adhered to even where the cost involved would be somewhat greater than the first cost of certain of our pavements. If these specifications were adopted quite generally by the profession there would not only be eliminated this possibility of waste, but there would be further elimination in the styles of brick in that the plain wire-cut lugless brick in both 3 and 3½-in. depths could be dropped. It might utimately be wise to drop, also, the other styles of 3-in. brick.

Bituminous Foundations for Street and Road Pavements

By Hugh W. Skidmore
Chicago Paving Laboratory

TWO essentially different schools of thought, as applied to pavement foundations, have been evolved. One seeks to overcome the destructive effect of the traffic loading, which at any instant may be converted into impact equivalent to several times the dead load, by means of a rigid slab possessing strength superior to the possible force of impact. The other adopts the principle of dissipating the blow by absorbing a considerable portion of it through a flexible structure, which is always in actual contact with the subgrade, thereby insuring greater uniformity of load distribution and functioning as a distributing medium or foundation and not as a deflector.

Flexible foundations include gravel, broken stone, water-bound macadam, bituminous macadam, and hot-mix bituminous concrete. They are usually classified as to value in a pavement structure in reverse of the order named with bituminous concrete as the highest type. It is estimated that there are 15,000,000 sq.yd. of "black base" giving satisfactory service in this country. The bituminous foundation structure, although possessing considerable beam strength, functions primarily as a shock reducer, that is, it *gives* slightly under the blow of impact in transmitting the load to the subgrade. Therefore, the design of this type places considerable reliance in the load-supporting power of the subgrade. Its use, then, is dependent upon a knowledge of the ability of the subgrade to support loads equal to the probable force of impact reduced by the slab strength residing in the bituminous structure; whereas the rigid type, regardless of the bearing power of the soil, must be built to sustain the entire force of impact. For this reason a much thicker rigid foundation is required under given traffic and subgrade conditions, as has been demonstrated by impact tests.

Even where soils are of questionable value as a subgrade,

bituminous foundations may still be employed economically, if an artificial subgrade of broken stone, gravel, boulders, or even cheaper materials, is first constructed. Where old macadam or gravel roads already exist, an excellent artificial subgrade is offered at almost negligible cost. If widening is necessary, this can usually be accomplished, as in the case of the Kingston Pike at Knoxville, Tenn. where "black base" was laid about 4 in. thick over the old macadam and 7 in. thick at the edges of the widened pavement.

Black-Base Practice

In the West, where the most extensive yardage of bituminous foundation has been laid, the general practice seems to be, in taking alternate bids, to specify 5 in. total depth for black-base pavement and 7 in. for portland cement concrete pavement of 1:2:3 mix. The general opinion appears to be that the black-base type is giving superior service. Almost universally bids for black-base pavements have been less than for either portland cement concrete pavement or asphalt wearing surface on portland cement concrete base. The saving has varied from 20 to 60c. per square yard.

Contractors are willing to guarantee black base as readily as portland cement concrete. The experience of contractors generally has been decidedly lower maintenance expense and lower first cost except in a very few instances where freight rates proved to be an extraordinary item. Assuming equal depth of foundation, the use of the same aggregate materials in both types, and portland cement concrete not to exceed 1:2:5 in richness of mixture, 90 per cent of contractors queried by the writer estimated a difference in initial cost of from nothing to 50c. per square yard loss for black base; 75 per cent estimated black base at from 25 to 50c. per square yard less than portland cement concrete. Since it is true that under similar traffic and subgrade conditions, less depth of black base is required, it will be seen that rigid foundations will usually cost substantially more than the highest type of flexible base.

The only objection raised by contractors to black-base construction is the possibility of idle equipment in the event of a protracted rainy season.

Cost Keeping on Highway Construction

A. R. Losh
Assistant Chief of Construction, U. S. Bureau of Public Roads

THE proper basis for a cost system is the four principal elements of cost allocated to the units of production: (a) Labor; (b) material; (c) equipment, and (d) administration or general. The products or highway construction to which these cost elements are assignable are: (a) right of way; (b) roadside, shoulders, and grade; (c) traveled way or roadway proper; (d) drainage channels or ditches and drains; (e) drainage structures or bridges and culverts, and (f) supplementary structures of miscellaneous road parts, such as guard rails, retaining walls, guide posts, etc.

Thus, there are six major products on each of which there may be four elements of expense or cost; consequently there are 24 cost divisions. Since general expense is not ordinarily ascertained directly on production but is prorated to the various operations the actual cost divisions with which the cost keeper is directly concerned are reduced to 18. It is believed that this is the minimum number of cost divisions which will provide a satisfactory highway cost keeping system. These cost divisions are susceptible of much further analysis by breaking them up into various operations. For example, a square yard of concrete roadway is one of the unit products. The cost divisions for this are, labor, materials, and equipment. To these three may be added the pro-rated general expense. For further analysis, this square yard of roadway may be subdivided into subgrade finishing, placing forms, hauling materials, mixing concrete, placing concrete, curing concrete, etc. This illustrates how the system may be extended to meet the requirements of any desired analysis.

In placing the cost items against the appropriate construction items the greatest difficulty appears to be with "equipment costs" and "administration costs."

The handling of equipment costs has been greatly simplified by the use of a rental factor computed to cover fixed charges, depreciation, overhauling, lost time, storage, and supervision. In the case of its own plant the bureau has prepared rental schedules for all units of equipment having a useful life of more than one working season and costing more than $25. Small tools and those which are usually worn out on one job are handled the same as materials. If greater accuracy is desirable for fiscal purposes, an annual appraisal of the equipment may be made and the depreciation, repair, storage and other charges pro-rated to the projects which have used the equipment.

Two suggestions are offered for the handling of general expense. First, it will be found advantageous to divide general expense into two parts, one of which includes those costs which are assignable directly to the project and the other the general administration costs of the organization which must be pro-rated to all its various projects. This latter part need not be considered in current cost reports as it does not in any way affect the efficiency of the construction organization on the project. This part of the general expense may be apportioned to the project upon its completion. The second suggestion is that the amount of general expense (project) taken up and pro-rated on current reports be a percentage of the total probable general expense, not greater than the percentage of the project completed. For example, if the project is only 10 per cent complete, pro-rate to completed work not more than 10 per cent of the total probable general expense. On projects where the cost of "moving in," "camp installation," "organizing," and "disorganizing" is of a considerable amount the unit construction costs are liable to be materially affected if this entire cost is distributed before the work is well under way.

Problems of Highway Contracting Which Affect Costs

By Henry H. Wilson
Managing Partner, Winston & Co., New York

BEARING in mind the present necessity and demand for lowered costs in every line of industry, particular attention should be directed to those contracting problems, a solution of which will result in decreased costs for highway building.

Internal Relationship.—It is good business for contractors to educate their competitors; it is good business and eliminates waste both to the contractor and owner, to seek out together the best means consistent with first class work and to assist in the standardization of methods and equipmen along those lines:

Risks.—The greatest reduction which could be brought about in contract prices would result if certain risks now assumed by the contractor were assumed by the state. A contractor can figure closely on work in direct proportion as elements of risk and uncertainty are eliminated. In many states the assumption of these elements of risk and uncertainty are required by the organic law and can only be escaped by access to public opinion as expressed through legislative action. To bring about a change in these laws will facilitate a more balanced and equitable form of contract.

It is also the problem of the higway contractor to use his influence to create a public sentiment which will countenance better paid and better qualified engineers and inspectors. One of the greatest problems confronting highway commissions and chief engineers is a salary scale which will permit them to employ men more competent and experienced. Contractors invariably find engineers and inspectors satisfactory in direct proportion as the latter possess integrity, intelligence and experience.

Specifications.—The problem of the contractor here is to co-operate in pointing out those requirements of specifications which entail increased costs without any commensurate advantage and those requirements which can be waived in the interests of economy without sacrificing quality. Under present laws, the difficulty with commissions and engineers (as to many changes for which contractors are asking) *lies not so much in their failure to*

recognize the just principle to apply as in finding a means to apply it practically.

Labor.—More uniform wages and working conditions for the various classes of skilled labor employed upon highways are believed to be a problem from whose solution benefit can be derived. If it were possible to develop some co-ordinated industry in the northern and border states, whereby highway labor might be retained the year around upon some productive work, contractors would be able to secure great economy and added efficiency from their organizations. Co-operation between concerns working in the same locality, in the matter of labor, will go far towards stabilizing conditions and creating greater efficiency.

Other Problems

Materials.—One problem here relates to the working out of a form of contract with material producers which will be a standard for the industry and more binding upon both contracting parties. Another problem is responsibility for rejected material. Some producers refuse to accept reponsibility for material condemned after unloading, while some engineers refuse to make final inspection until the material is unloaded. Uniformity of practice and understanding will remove an element of anxiety and loss to many contractors and will reflect itself in lower contract prices.

Transportation.—Our chief problem, in this connection, is to assist the railroads and indirectly the public, in the elimination of waste and expense, by so designing work and unloading facilities as to provide for prompt release of cars.

Standardization. — Standardization of equipment holds great possibilities for efficiency and economy and organized construction is already moving in this direction. Here again the working out of standard specifications for the country at large will do much to facilitate matters as it frequently happens that equipment suitable for construction in one state it not suitable in another.

Surety Bonds.—Much demoralization has been caused by the bonding of irresponsible concerns. With the past ten years, there has been an increase of approximately 100 per cent, in bond premiums and, within the past thirty years, the increase has been comparatively greater.

Minnesota's Highway Financing

By C. M. Babcock
State Highway Commissioner of Minnesota

THE state constitution of Minnesota was amended at the last session of the legislature to provide for a state trunk highway system, 7,000 miles in extent out of a total of 100,000 miles in the state, the funds for its improvement and maintenance to be raised by a tax upon motor vehicles. The law prescribes that 40 per cent of the funds shall be used for maintenance and minor betterments.

The detail of levying the motor vehicle tax was wisely left indefinite in the constitution, but the legislature putting it into effect used 2 per cent of the value of motor vehicles as the basis of taxation, which should not be the only factor; it is expected that, in addition to valuation, there will also be a levy made either upon the weight of the vehicles or upon the gasoline consumption. Under the present system the current revenues from motor vehicles amount to approximately $6,000,000 per year derived from the registration of about 330,000 vehicles and averaging less than $20 per car, with a minimum of $12 on passenger cars and $15 on trucks.

The constitutional amendment also allowed the legislature to issue bonds of the State in an amount not exceeding $10,000,000 per year, with a maximum limitation of $75,000,000 outstanding at any one time, but it was not deemed necessary to issue any bonds for the first biennium, for the constitution allowed counties to issue their bonds to anticipate the State construction of trunk highways within the counties, the aggregate of these county bonds being approximately $14,000,000 in the first two year period.

Thus we have the total of funds for the year 1921 as follows: Federal aid $2,840,000; state trunk highways fund derived from motor vehicles revenue, $5,750,000; state aid from one-mill tax, $2,084,000; county trunk highway bonds, $8,250,000; county road and bridge levies, $10,843,682; township road funds, $6,862,560; village road levies, $1,308,794; or a total of $37,940,000. Of this total, approximately $15,000,000 was used on the trunk or primary highway system of 7,000 miles and the remainder, $23,000,000 on the secondary system of county and town roads.

The foregoing summarizes the sources and amounts of Minnesota highway funds. As will be noted, they are derived from current tax levies on all property in the State, from bond issues for permanent construction and from a direct tax upon the user of the road. From this it will be seen that Minnesota recognizes the equity of three phases of highway financing: First, that all property is benefited by the improvement of transportation facilities; second, that it is reasonable and good business to borrow money for the purpose of making permanent improvements on highways as well as school houses and other public buildings, requiring those who will later enjoy these facilities to bear a part of the cost of them; and third, exacting a part of the expense for the construction and maintenance of roads from the motor vehicles which cause the greatest damage to the public highways and make necessary their greater improvement.

Sentiment For Increased Tax

There is a growing sentiment in Minnesota for increased taxes on motor vehicles, particularly motor trucks, and the people of our state are inclined to believe that the transportation companies using public highways for commercial, passenger and express uses should pay gross earnings taxes somewhat in the same manner as the railroads are required to do. It is very evident that taxation for highway purposes throughout the whole country is shifting from general property to vehicles using the roads, on the theory that the users of the highways should bear a greater share of the road construction and maintenance costs, and due also to the necessity of supplying additional funds for the more adequate highways demanded by the public.

Road officials should carefully analyze the situation before agreeing to the single standard of gasoline tax which might seriously affect the amount of available funds for road improvement. The popular idea is that a tax of 1 or 2c. per gallon would bring in sufficient revenues, but we find in Minnesota that the gasoline used in the State last year was 117,000,000 gal. which would have required a tax of 5c. for every gallon shipped into the state to produce the sum derived under the present motor-vehicle tax schedule.

Notable Drought in Great Britain Most Serious in Years

In 11 months of 1921 only 13.26 in. of rain was registered in London whereas the normal is around 23 in.; in other words, London is still 46.7 per cent short of her average rainfall. The previous smallest records were 16.93 in. in 1864 and 17.69 in 1898. The following records for the various quarters of England, Scotland and Ireland show that Scotland has suffered least, one section of it having even an excess of rain for the 11-month period:

	Fall to Nov. 30, 1921 In.	Normal Fall in this Period	Percentage Above or Below Normal
England, N. E.	15.65	21.05	—15
England, N. W.	25.09	29.35	—15
England, E.	11.72	20.10	—40
England, Midlands	15.61	22.50	—30
England, S. E.	11.40	22.70	—50
England, S. W.	19.01	31.80	—40
Scotland, N.	44.03	41.60	+ 5
Scotland, E.	22.71	26.35	—15
Scotland, W.	39.91	38.73	+ 5
Ireland, N.	28.63	32.00	—10
Ireland, S.	27.29	33.05	—15
Channel	13.21	26.40	—50

Development of Light Railways in Great Britain

Standard Gage Preferable; or 30-In. for Isolated Lines—Light Rail and Load—Economic Operation—Road Motors

ECONOMIC transportation facilities for agricultural and other lightly populated districts by means of light railways, with low cost of construction and operation have been advocated in England for many years. Lack of progress in this direction led to the appointment of a government committee of investigation in 1920. In its report the committee attributes the slow and unsystematic progress before 1896 to restrictive legislation. The Light Railways Act of 1896 and the amending Act of 1912 represented a substantial advance, but have not fostered the development of light railways to an extent comparable with that attained in Continental countries. Of the $5,000,000 made available by the Act of 1896 for advance to light railway companies, only about 20 per cent had been disbursed up to the end of 1918, and of this the greater part was advanced during the earlier years. The following is a summary of the report:

Construction Cost—Actual cost of existing lines cannot be ascertained definitely, as heavy discounts often make a wide difference between the nominal amount of capital issued and the actual cash amount of capital raised. For narrow gage lines the cost has varied from $16,665 to $34,030 per mile. For standard gage it has ranged from $17,505 per mile for a line in an agricultural district to $126,310 per mile for a line having a fairly heavy industrial traffic.

Narrow or Standard Gage—The adoption of a gage distinctly narrower than the standard gage may effect a saving in length by use of sharper curves, and may effect economies in earthwork, ballast and ties. Where a light railway has to be laid on a public road a departure from the standard gage offers marked advantages. Narrow-gage railways carrying heavy engines and capacious rolling-stock have been built in South Africa and India, and an equally high ratio of paying load to dead load may be attained in narrow-gage equipment. Where it is decided to depart from the standard, the gage should be 2 ft. 6 in.

On the other hand, there is the disadvantage of transhipment. In certain cases, this difficulty may be overcome by organization and by the use of labor-saving appliances, especially when dumping of material is practicable. Or the objection may be more than counterbalanced by advantages incident to narrow-gage construction and operation, especially where a light railway is more than 20 miles long or has no prospect of connection with a main-line system. But except in rare instances where passenger traffic only has to be transferred, a break of gage is disadvantageous and should only be resorted to when it is clear that the objection to transhipment can be offset or overcome.

Weight of Rail—There should be a greater variation in relation to weight of rail to axle load. A sliding scale varying by 5-lb. increments is proposed: 30-lb. rails for 4- to 6-ton loads, 40-lb. for 6 to 8 tons, 50-lb. for 8 to 10 tons, 60-lb. for 11 to 13 tons, and 70-lb. rails for 15 to 17 tons.

Roads and Grade Crossings—In continental countries it is usual to operate railway equipment on tracks in streets and roads. Restrictions against such practice in Great Britain should be abolished. Light railways should be of two classes, with maximum speeds of 25 and 15 m.p.h. respectively. Greater economy in grade crossing protection could be attained without loss of safety or convenience on the low-speed lines, but even on the higher speed lines there is room for a greater departure from main-line standards. Gates and gatekeepers should be employed less extensively, adequate protection being afforded by speed limits, whistle boards, cattle guards and warning signs.

Light Railways and Road Motors—In comparing the economic values of road motor and light railway service, individual cases must be considered on their merits. A road motor service may be a desirable alternative, and no light railway should be authorized where such a service is equally suitable and is likely to be established within a reasonable time. The policy should be to aim at co-operation rather than competition between light railway and road motor projects.

Other Conclusions—A new conception of the character and functions of a light railway is necessary. Light railways differ essentially from main lines and must depend for success upon the adoption of different standards of construction and operation. A lower standard of speed is a first essential. The poor financial results obtained from light railways in Great Britain have not been due to failure to exercise economy in operating expenses, but rather to the smallness of the earnings in relation to the capital involved.

Safety Provisions

Requirements as to signals, switching, etc., should not be relaxed in favor of the higher speed lines, but on the lower speed lines signals should not be required. Fencing should be provided only where local conditions, including the speed of trains, render it essential. Protection of crossings by gates and gatekeepers should be similarly limited. Where a road and light railway intersect, a bridge should not be provided except where it would be more economical than a grade crossing or where other conditions render a bridge essential. Undue weight should not be given to arguments presented by local authorities for bridges in place of grade crossings.

Station accommodations for passenger traffic should be simple shelters, except at important stations. Halts should suffice at wayside places. Tickets, fares and parcels traffic should be dealt with by the train conductors. Station facilities for freight traffic should be closely adjusted to the requirements. Economy in rolling stock should be obtained by standardization of types and parts. Economy may be effected, and traffic increased by the use of steam or internal-combustion rail-motor cars for passenger service. Greater economy in maintenance and operation is desirable. Existing facilities for the handling of traffic should be improved, as by the extension of sidings at stations and exchange points. In this respect the co-operation of the main-line companies would benefit both the light and main-line railways.

Saturated Bank Causes Turkey Creek Cave-In

A CAVE-IN of about 1,000 cu.yd. of the west embankment of Turkey Creek, Kansas City, Mo., occurred recently. Ultimately the creek will be put into the double-concrete sewer described in the *Engineering News-Record*, Nov. 17, p. 815. Water from a broken 4-in. service main saturated the sandy loam back of a loose-laid riprap wall. The operation of a heavy crane back and forth over this bank of the creek started the leak or break in the main, in the opinion of the engineer of sewers, Paul H. Hartung. When sufficiently saturated the embankment slid into the creek, carrying with it the tracks of the St. Louis-San Francisco, and Missouri, Kansas and Texas railroads. A limited of the "Frisco" was stopped just in time to prevent its plunging into the slide as no one saw the accident which occurred between 9 and 11 p.m. A pile trestle has been built across the depression and Mr. Hartung stated that progress on the sewer has not been affected to any great extent.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

A. A. E. in Baltimore Favor Licensing

Sir—In the *Engineering News-Record*, issue of January 19, p. 129, there appears an article entitled "Engineers Club of Baltimore Opposes Licensing." In the body of this article the following statement occurs: "The meeting was of a very representative character, including local members of the American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Society of Civil Engineers, American Chemical Society and the American Association of Engineers."

This article is misleading in that it intimates that the American Association of Engineers is opposed to licensing, which is not a fact. It was the father of the original licensing bill in Maryland two years ago and any members (and they were very few) of the Baltimore Chapter, A. A. E. at the above meeting were, I am sure, in favor of licensing, and if they were opposed the expressions of opinion were as individuals and not as members of the A. A. E.

Baltimore, Jan. 21 B. L. CROZIER,
Secy., Baltimore Chapter, A. A. E.

For and Against a Small Dam

Sir—The writer has noted with considerable interest, an article in *Engineering News-Record*, Dec. 22, 1921, p. 1018, "Two Small Dams Good Examples of Amateur Engineering," especially that part of the article which was furnished by Gale Dixon, chief engineer of the Bureau of Water Works Improvement, of Akron, Ohio. The writer is the Secretary-Treasurer of the Wycoalin Club Co., building this dam.

The owners of the "unsafe mill dam," to which Mr. Dixon refers, brought a suit of injunction to prevent us from constructing our dam, relying principally upon an attack as to its stability. A temporary injunction was granted, pending the hearing of the case. At this juncture Mr. Dixon was employed by the owners of the "unsafe mill dam" as an expert witness and counselor to condemn our structure. After a trial which lasted for nine days, the judge dismissed the injunction with a minor suggestion with which we gladly complied.

In the deductions which Mr. Dixon draws, he ignores supplements to the plans and specifications which were made prior to his injection into the suit and to which he had access during the trial. The dam is not yet completed, but the work is progressing and it will be completed in the early spring.

It seems to me it would have been a very gracious thing for Mr. Dixon to have done in the interest of candor and sincerity, in making his report, to have stated that his engineering skill and technique had been rejected by the Court, and he might then, after having stated the facts fully and frankly, have said with some degree of consistency, that the dam was not designed or being built according to the most advanced engineering practice, as no profession for such a structure was advanced by our club.

Mr. Dixon's statement as to the valley floor at the dam site, having a "surface layer of some 14 ft. of soft muck and silt overlying gravel and sand," was entirely out of keeping with the testimony of all the witnesses in the case (himself included) that this clay, muck and silt valley floor reached down from 3½ to 5 ft.

Our plans and specifications were drawn by Major W. A. Wolffe, now of the Department of Public Works, Pittsburgh, Pa., a practical engineer with an experience covering twelve or fifteen years; they were submitted to the Superintendent of the Board of Public Works of the State of Ohio, his chief engineer and the canal land agent, all practical engineers of long experience, who even made a trip to the site of the dam in investigating the application of the plans and specifications, and whose depositions approving same were submitted at the trial; and the plans of our dam were supported in every major particular by the opinions of several engineers to whom they were submitted. C. W. STUART,

Massillon, Ohio, Jan. 20. Secretary-Treasurer,
The Wycoalin Club Company.

[This letter was submitted to Mr. Dixon, who has replied as follows: EDITOR].

Mr. Stuart's identification of the structure which I described is accurate.

The thickness of the layer of "clay and swamp muck" overlying the "gravel" at the dam site is shown correctly in the sketches as 4 ft.; in the third line of the left-hand column of page 1019 the thickness of "soft muck and silt overlying the gravel and sand" appears as 14 ft. through a typographical error. If you will refer to your copy, I believe you will find that I changed the original figure from 6 ft. to 4 ft. in blue pencil. [Mr. Dixon is correct.—EDITOR.]

The generic points of interest to hydraulic engineers in this case are three in number:—

(1) The use of a spillway design which at first glance might appear simple and economical, but which if conservatively designed in all its component parts would actually be more expensive than the more usual types.

(2) The lack of the precautions which a long and bitter experience has demonstrated to be necessary to successfully hold water by an earth dam on soft foundation.

(3) The decision of an eminent jurist—to be precise, Judge E. D. Fritch of the Summit County common pleas court—in an injunction suit that was brought against the construction of this dam, from which the following full paragraph is quoted:

"Criticism has been made of the release pipe, and especially owing to the fact that it has a gate valve at the lower end. I might say, in that connection, that the Court has no difficulty in finding, in this case, that this dam is not being constructed according to the most advanced engineering ideas on that subject, not in any respect, but the departures from that are not so great, in the judgment of the Court, as to warrant the interference, by way of injunction, except, possibly, in one particular, which I will discuss. On the other hand, the Court does not find that it has authority to compel the construction of the dam according to the most advanced engineering practice, but it might be advisable if the Court or some public body had that authority in this state to require structures of this kind to be built according to the very best sort of practice but the Court does not find that it has authority to enforce anything of that kind." GALE DIXON.

Akron, Ohio, Jan. 26.

More on Sand Shifting Preventives

Sir—Commenting on R. A. Hill's letter on grass as a sand-shifting preventive in *Engineering News-Record*, Jan. 5, p. 32, I had an interesting experience in which sage brush figured in the construction of a railroad and pipe line across the Sinai Desert from Egypt to Palestine—200 miles of shifting, drifting sand, and a region wherein rain was comparatively unknown. We revetted the foundation for both railroad and pipe line with cut sage brush, which grows up to a height of about 12 in., in order to prevent the sand from shifting and covering up the railroad tracks, and in order to prevent the pipe line covering falling off in storms. Although the desert is practically without rain there are heavy dews, and some mist, and it was found that the sage brush absolutely prevented the drifting of sand and actually took root and bonded itself and the surrounding material into a perfect revetment.

I have reason to believe that despite the terrific sand storms which occur in this desert, at times piling up drifts 10 ft. deep, that the railway and pipe line mentioned above, which were left by us at the close of the war three years ago, are still intact and in good shape and the sage brush revetment has so grown that it is now a permanent preventive of drifting sand. T. W. FAIRHURST,

Vancouver, B. C., Jan. 17. Sales Engineer, Vancouver Machinery Depot, Ltd.

NEWS OF THE WEEK

New York, February 2, 1922

Wood Preservers' Association Meets in Chicago

Adopts Wood-Stave Pipe Specifications —Service Test Results for Bridges, Piles and Ties.

Convinced of the benefits of present methods of preventing decay and natural destruction of wood, the American Wood Preservers' Association, at its annual meeting Jan. 24-26 in Chicago, emphasized the need for the responsibility of the organization reducing the enormous waste in timber and increasing the comparatively small amount of wood—4 per cent out of 50 million feet—that is treated. Treatment now limited chiefly to cross ties, the association maintains, should be extended to such fields as car lumber and buildings, where practically no preservatives are utilized. Preservation for 20 per cent of the 50 billion feet, instead of 4 per cent, is the organization's goal.

Scope of Program

R. H. Aishton, president of the American Railway Association, in the opening address, startled the members when he told them that they needed a publicity agent to sell waste prevention by wood preservation to railroad executives. Apparently he had not heard that a well-equipped service bureau of the association, with a director and office force, was organized months ago and is now besieged with calls for lectures at colleges and engineering meetings; that 80 per cent of the dues of members go into publications of proceedings and bulletins; that car sills and floors are being treated on the Burlington; that wood-stave pipe treatment is now a success; that Douglas fir can now be treated successfully since "needling" or perforating had been perfected; that the experimental stage of treating mine timbers had passed and actual every-day use was an economy; that 80 per cent of the destruction of piles from marine borers in San Francisco Bay was due to misuse and injury in handling treated piles rather than to inefficiency of treatment; and that sodium flouride could be used on floors and house lumber. All of these facts were brought out at the meeting. Mr. Aishton should have stayed.

Other subjects of interest to the engineer included a proof of the solubility theory as the mechanism by which toxic properties are carried by oils into wood; tentative new wood and flooring specifications; a new vacuum drying method; the feasibility of introducing tropical ties into the United States; and a resolution passed unanimously protesting against the proposed change of the U. S. Bureau of Forestry from the Department of Agriculture to the Department of the Interior.

As a joint meeting with the Western Society of Engineers, A. F. Robinson, bridge engineer, Santa Fe System, gave a historical sketch of his road's experi-

(Continued on p. 210)

Roof Collapse of Washington Theater Kills 95 Spectators

Failure Occurs During Performance at Time of Heavy Snowstorm—No Evidence of Overloading—Main Members of Framing Not Broken or Buckled—Unseating of Truss From Wall Support Suggested by Displaced North Wall

Collapse of the roof and part of the balcony of the Knickerbocker Theater, a large moving-picture house in Washington, D. C., during a performance on Jan. 27, killed 95 persons and injured nearly 200 others. The accident occurred about 9 p.m., shortly after the beginning of the performance. A phenomenally heavy snow-storm was raging at the time, and the house was only partly filled; the attendance is said to have been about 500. Rescue work had to contend with great difficulties because of the snow-clogged condition of the streets, but was so efficiently organized by the Engineer Commissioner of the District, Col. Charles Keller, that the wreckage had been thoroughly searched by noon the following day and by evening practically all the débris had been removed, the tangled steelwork having been cut apart by torches during the rescue work.

Excessive weight on the roof from the heavy fall of snow was at first thought responsible for the failure, but examination of the wreckage by a representative of *Engineering News-Record* revealed no evidence of overloading or primary failure of a main carrying part. Investigations are under way by the Bureau of Building Inspection, the District Attorney and other local authorities, and positive statements of conditions and causes cannot be made at present. The following statements are given as results of a preliminary survey of facts and conditions, and represent merely the probable deductions from this survey.

Type of Structure

The Knickerbocker Theater, located at 18th St. and Columbia Road, N. W., was a modern structure with tile main walls, steel framing of balcony, roof and service floors, and reinforced-concrete floor and roof slabs. It was built about four years ago and has been in service since that time without exhibiting defects or instability so far as known. The architect was R. S. Geare, and the steelwork was designed by J. H. Ford, of the Union Iron Works, both of Washington. The builder was Frank L. Wagner. So far as can be learned at the moment the loads and stresses for which the structure was designed were safe and in accord with good practice. Officials of the Bureau of Building Inspection state that to their best knowledge it was constructed according to the approved plans and in satisfactory workmanlike manner.

The structure occupies a roughly triangular plot at the acute angle formed by 18th St., which runs north and Columbia Road, which runs northeasterly and curves toward the intersection. At the sharp corner formed by the street intersection is the stage; the rear of the main seating floor and balcony extends along the southerly

Harding Would Limit Federal Aid to $75,000,000 Yearly

That the federal government's annual contribution to the federal-aid fund be limited to $75,000,000 per annum for the present is the wish of President Harding. He expressed this desire when members of the House Committee on Roads called at the executive offices to discuss with him the legislation which would carry the authorization for the appropriations for the four-year period beginning July 1, 1923.

Rivers and Harbors Congress to Meet in March

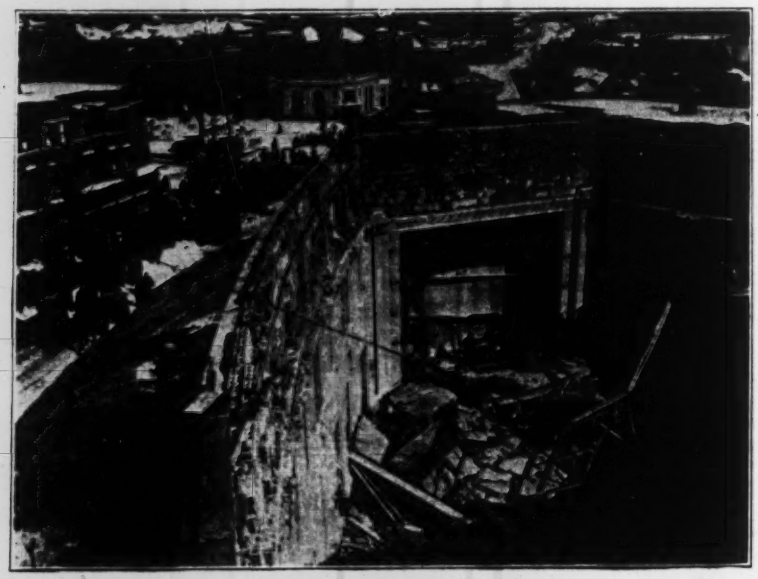
The National Rivers and Harbors Congress will hold its seventeenth convention at the New Willard Hotel, Washington, D. C., March 1 and 2. The evening session on March 1 is to be devoted to a discussion of the proposed St. Lawrence River project. The secretary of the congress is S. A. Thompson, Colorado Building, Washingon, D. C.

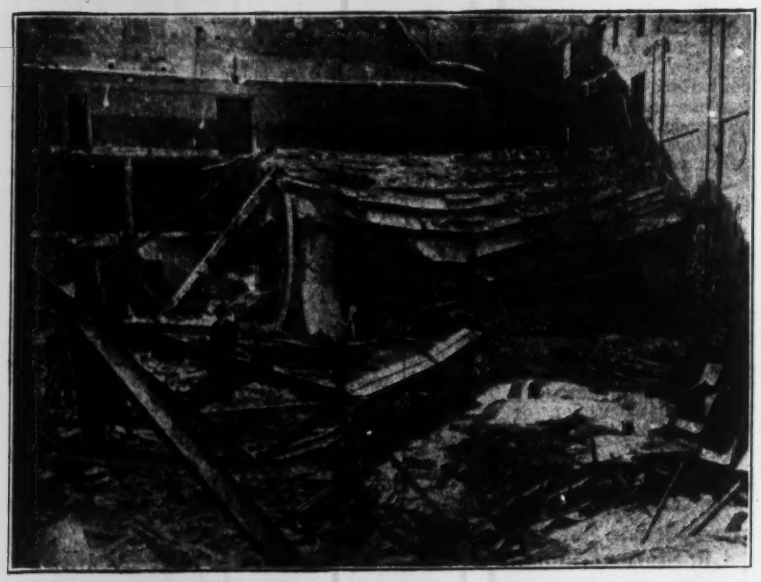
Questionnaire on Sewage Disposal in State of Indiana

The Engineering Division of the Indiana Conservation Department is sending out a sewage disposal questionnaire to the municipalities of the state. Maps showing the pollution of various streams will be prepared. John C. Diggs is sanitary engineer and Richard Lueber is director of the department.

New York City Plans Triborough Bridge

An appropriation to pay for surveys and borings for a bridge connecting Manhattan, Bronx and Queens boroughs, New York City, has been requested of the city's financial authorities by the Department of Plant and Structures. The bridge as proposed would extend from 125th St. and First Ave., Manhattan, to St. Ann's Ave. and Southern Blvd., Bronx, and thence to Second and Potter Aves., Queens, and would be about 15,000 ft. long. At present there is no connection from Manhattan to Long Island north of the Queensboro Bridge except one ferry line.





Inside the Theater After the Collapse

Upper—Looking Northeast Along the Curved Tile Wall on the Columbia Road Side. Northerly Auxiliary Truss (see text) Trailing from Wall to Floor.

Middle—Looking South Toward the Rear Wall and Part of Balcony Still in Place.

Bottom—Looking West Toward the Columbia Road Wall and the Part of Balcony Still in Place.

wall, which is shaped to an arc about the stage corner. Thus the seating space converges toward the stage, its left wall being formed by the curved wall along Columbia Road, while its right wall is parallel to 18th St., and is separated from the street wall by a lobby space 10 or 15 ft. wide.

Type of Framing

To suit this irregular ground plan the roof framing centered about a main truss some 55 ft. in span, 5½ ft. deep, running parallel to 18th St., about 56 ft. west of the right-hand wall of the seating space. The north end of this truss rested on a seat in the Columbia Road wall, which wall formed a sharp angle with the line of the truss; its south end rested on a column (*A*) extending through the balcony and carrying part of the balcony framing. Three trusses spanned east to west between the main truss and the east wall, engaging it at the first, third and fifth panel-points of the six-panel truss. A shorter fourth truss, parallel to them and one bay south, spanned from the east wall to a second column (*B*) about 20 feet southeast of the main column (*A*), being framed into the column. An I-beam connected the tops of *A* and *B*. Column *B* also served as a balcony support. West of the main truss, three principal carrying members extended back to Columbia Road wall, being in line with the three trusses framing into the east side of the main truss. Of these three members, the two northerly ones were beams, the southerly one a truss. Thus the main truss was held by trusses on both sides, at a point only 8 or 9 ft. from the column; except for this stiffening in an east-west direction and the staying action of the main truss in a north-south direction, the top of the main column *A*; was unbraced. Filling the meshwork of this main framing were purlin beams running north and south, and upon these rested a mesh-reinforced concrete roof slab.

Where the trusses were supported on walls (north end of the main truss, and east ends of the secondary trusses), seats were provided consisting of one or two short I-beams, three or four to seven or eight feet long, built in the tile wall. The trusses merely rested on these seat-beams, but were not bolted or otherwise fastened to them. Beams resting on walls were in some cases supported by metal wall plates and anchored by single bent-rod anchors; in other cases they merely rested on the tile.

Of the roof framing none remains in place, but the northerly auxiliary truss is wedged between floor and east wall, though its east end is some distance below its original seat. The main truss, cut into seven or eight sections by the cutting torches of the rescuers, is on the floor, slightly east of its original position, and with its northerly end swung around somewhat eastward; just after the collapse it lay almost under

its position in the roof, but hanging on a corner of the balcony, moved some 10 or 15 ft. south of its true position and at its north end, which rested on the floor, swung to the east. The main column still stands undisturbed, up to a cover-plate splice just above the balcony floor; the upper part, partly twisted free at this splice, leaned over southward till it bore against the south wall. It was later dropped, so that now the cap touches the ground seven or eight feet from the foot of the column. The truss rested on top of this column and was fastened to it by six bolts.

The column cap was formed by an angle knee on each flange, one on each side of the web, the former having each two bolt holes and the latter one. The column was set with the plane of the web pointing toward the stage, and the truss therefore made an angle of about 45 deg. with the column axes. There was a severe wrenching between column and truss at some time during the collapse, as shown by a twist of the end of the bottom of the chord and the fact that the front knee of the column cap is bent downward and nearly torn off. The stub of one bolt, bent and torn off, remains in the truss chord-flange.

The main truss itself shows no break and little distortion. It was quite stiff laterally, the flanges being made up each of two channels 12 in. x 20½ lb. set about ⅞ in. back to back, and a cover plate generally 12 in. wide. While the cover plates were not spliced where they changed thickness, the truss does not exhibit any buckling. Its sections show slight bends at the panel points, all representing a curve concave eastward (to the right), referred to the original position of the truss.

Column *B*, which had been removed with other débris to a dump, is bent at the level of the bottom chord of its truss, and completely doubled up on itself just below the balcony level, besides being torn apart at the splice above the balcony floor. Of two other balcony columns, the one near the north end is intact, but forced out of position by the crushing of the balcony overhang; the south one, found at the dump, is twisted and torn apart through the solid metal just below the bottom chord of the balcony truss framed into it.

North Wall Leaning

The north wall, which is the curved wall along Columbia Road, leans outward about 5 in. and is separated from the short diagonal proscenium wall at the stage by a crack extending to the bottom. It is not known whether this wall became displaced before or during the collapse, and it is not known whether it received a blow. The beams forming the seat of the main truss in this wall are still in place. The same is true of the seats of the secondary trusses in the east wall, but these have their upper flanges bent down as if the trusses pivoted on them sharply; the most marked appearance of this kind is at the second and third from the north, while the north one shows a grinding of the edges of the truss chord at its tip.

Below, the northwesterly half of the balcony is still in place, with its front cantilever part broken down by bending of the cantilever trusses. The southeast half of the balcony is gone. No reason was found for concluding that the balcony failure was other than a result of the fall of the roof.

Report on $60,000,000 Water Supply for Boston District

A 400-billion gallon storage reservoir on the Ware River at Enfield, thirty miles from Worcester, Mass., and an aqueduct connecting the proposed reservoir with the Wachusett storage reservoir of the Boston Metropolitan Water District, at an estimated cost of $60,000,000, are recommended in the majority report of the joint board representing the State Department of Health and the Metropolitan District Commission submitted to the legislature Jan. 28. The report is signed by Dr. Eugene R. Kelly, commissioner of health of Massachusetts, and X. H. Goodnough, chief engineer of the Depart . . of Public Health. A minority report by James A. Bailey, chairman of the Metropolitan District Commission, the third member of the joint board, maintains that the present water supply to the district would be sufficient until 1935 if resort were had to filtration (presumably of portions of the supply).

Such eyewitness stories as were obtainable indicated that the collapse was noticed first at the front, over the orchestra. This is in a region covered by beam framing between the north secondary truss and the north wall. Since no local failure at this point could have affected the main framing, it is concluded that the failure here was a result of preceding displacement of the main framing. The appearance of the wreckage points to an unseating of the north end of the main truss, leading to the fall of this truss and the forward part of the roof, followed by destruction of the two columns and their subsidiary truss and beam framing; the balcony was then crushed down by the falling masses from above.

However, the stability of the column connections as being a possible source of the unseating movement is still receiving study, and none of the local authorities is yet willing to express an opinion on the probable cause of the disaster. It is believed that the snow weight, assuming rather more than 24 in. of light snow (water equivalent probably less than 2½ in.), did not exceed 12 pound per sq.ft., which is only half the 25-lb. live-load assumed in the design and only a small fraction of the dead-load.

Some attention has been given the pressure of a large ventilating hood on the front part of the auditorium roof, containing a large fan and motor. Vibration set up by this machinery has been thought possibly responsible for loosening the connections of the roof—presumably the connection of steelwork to walls. Up to the present, however, no definite knowledge as to the operating condition of this fan has come to light, or any indication that it did, in fact, set up unusual vibration. At present this supposition seems to have little more foundation than similar talk of vibratory effects of street-car traffic in Columbia Road, supported by statements of nearby residents that their houses are shaken by the car traffic.

The real trouble is unquestionably to be sought in the structure itself; and here, while some details may be criticized, especially the staying of the tops of the columns, there seems no reason to suspect the framing, but—in view of the damaged condition of the north wall—rather the walls and their support of the framework. Expansion and contraction movement of the steelwork are being considered as a possible cause of creep of the main truss on its wall support, leading to its final unseating.

Colorado River Conference at Washington

A propitious start toward an agreement as to the utilization of the waters of the Colorado River, to which the representatives of the several states directly concerned and of the federal government will subscribe, was made at the first meeting of the Colorado River Commission, which was held in Washington, January 26. Secretary of Commerce Hoover was elected permanent chairman of the Commission. An effort will be made to draw up what Mr. Hoover calls a charter for the development of the Colorado River. It is believed fundamental principles can be laid down for this development which will permit of unanimous recommendations to Congress and to the legislatures of the seven states concerned.

Secretary Weeks Submits Ford Offer for Muscle Shoals

[*Washington Correspondence*]

In submitting Henry Ford's Muscle Shoals offer to Congress, on Feb. 1, Secretary of War Weeks made no recommendations, but indulged in very significant comment. He pointed out that the project might prove unprofitable to Mr. Ford and that there should be some assurance that the contracts made will be carried out.

Secretary Weeks expressed the opinion that it would be better policy to limit the contract to a term of fifty years, so as to conform to the policy as set out in the water-power act. One hundred years is too long a time, he believes, in view of the unknown possibilities surrounding water-power developments and the probability of changes whichh may be made especially in the transmission of power.

In case the Ford offer is not accepted, Secretary Weeks urged that the Wilson Dam be completed by the Government. He believes the returns from the sale of power will be profitable and that the project carried forward by the Government ultimately will be more profitable to the public than would the acceptance of the Ford offer.

Secretary Weeks also made public an analysis of the Ford offer, by the Ordnance Department, in which Major General Williams, among other things, says the Ford offer, from the standpoint of the Ordnance Department, has the very important advantage of assisting materially in the development of nitrogen preparedness and has the disadvantages of conflicting with contractual obligations with the American Cyanamid Co., and the Alabama Power Company and of making a net return to the Government of less than $5,000,000 for properties which have an estimated salvage value of some $16,000,000.

Secretary Weeks pointed out that he is without authority to dispose of the property as a whole, and that it is peculiarly the province of Congress to weigh the considerations involved in this negotiation.

Fauntleroy Appointed Highway Engineer of Texas

Capt. J. D. Fauntleroy, former district engineer, U. S. Bureau of Public Roads, with jurisdiction over Texas, Oklahoma, Arkansas and Louisiana, has been elected to succeed Rollen J. Windrow as state highway engineer of Texas at a salary of $9,000 per year. For the past five years, Capt. Fauntleroy has been the Federal Government's highway engineer representative with headquarters at Ft. Worth. He is a graduate of the Virginia Military Institute, and has been in the federal service since 1891. Prior to the Spanish-American War he was engaged in railroad engineering and served in both the Spanish war and the Phillipine insurrection. After leaving the army Capt. Fauntleroy engaged in highway work in the Phillipines for three years, two years in sanitary engineering, five years in the U. S. Reclamation Service and one year as manager of a construction company in Wyoming. He has been with the U. S. Bureau of Public Roads for the past eight years, five of which have been spent principally in Texas.

Canadian Engineers Hold Annual Meeting

Election of officers for the coming year, the establishment of three new chapters of the society, the presentation of technical discussions, and various social gatherings were features of the annual meeting of the Engineering Institute of Canada held at the Montreal headquarters of the society Jan. 24-25.

The officers elected for 1922 are: President, J. G. Sullivan, consulting engineer; and vice-presidents, Brig. Gen. C. B. Mitchell and Arthur Surveyer. Three new branches of the society were founded at Sydney, Nova Scotia, London, Ont., and Lethbridge, Alberta, respectively. Leading technical papers were: one explaining the design features of the latest hydro-electric development of the Shawinigan Water & Power Co., read by Julian C. Smith, a member of the institute and vice-president and general manager of the Shawinigan Water & Power Co.; and an illustrated lecture presented by Major Draper on the construction of the new St. John cantilever bridge.

The social features of the society's meeting included a visit to the Dominion Engineering Works at Rockfield, the annual banquet and a smoking concert.

Illinois Drainage Association Considers Legislation

At the annual meeting of the Illinois Drainage and Rivers Improvement Association, held at Springfield, Ill., Jan. 11 and 12, the most important matters discussed were the promotion of the drainage provision now before the state constitutional convention and the proposed creation of a state division of reclamation by the legislature in 1923. The papers included a review of what various states are doing to aid land reclamation, by G. W. Pickels, and a discussion of the economic benefits of such reclamation in Illinois, by Ivan Wright, University of Illinois. The president is A. L. Maxwell, Lawrenceville; secretary, G. W. Pickels, Urbana Ill.

Wood Preservers Convention

(*Concluded from p. 207*)

ence with treated timber in bridges which was replete with statistics and service records, successes, failures and difficulties.

A strenuous debate was precipitated by a paper by Earl Stimson, chief engineer of maintenance, B. & O. R.R., on the subject "Should the Increased Cost of Treating Ties be Charged to Maintenance or Capital Account?" From a practical standpoint and because of the enormous amount of recording necessary if charged to capital, the consensus of opinion seemed to favor charging to maintenance. However, a resolution was passed calling for a committee to take up the matter with the Interstate Commerce Committee.

A tabulation of 374 records on 38 species involving 923,000 ties was presented by the committee on service test records, of which S. D. Cooper, assistant manager, treating plants, Santa Fe System, is chairman. The records were compiled by the Forest Products Laboratory. In discussing the report Mr. Cooper said that when 60 per cent of the ties in a track had been removed the test was considered complete. The report stated that only completed tests should be published, a position to which J. H. Waterman, in charge of timber preservation, C. B. & Q. R.R., objected.

Wood-Stave Pipe Treatment

A specification for creosote treatment of Douglas fir wood-pipe staves was adopted and ordered sent to letter ballot. Staves dried to at least 20 per cent moisture are called for. Treatment is to be by the boiling-under-vacuum, empty-cell-process. While 8 lb. was written into the specification as the amount of oil to be retained, the association finally left the amount blank. A feature not put into the specification, but borne out by experiments reported in a paper by H. D. Coale, chief engineer, Continental Pipe Manufacturing Co., was that sapwood should not be considered a defect in staves to be treated, as in every case the sapwood was completely penetrated by the creosote oil.

F. D. Mattos, manager, treating plants, Southern Pacific Co., as chairman of the San Francisco Bay marine piling committee reported progress for the second year of a three-year progress. Ravages of the teredo continue but in diminished form as the unprotected material on which to work becomes less and the salinity of the upper regions got back to normal after the drought conditions. Biological tests are to be continued, the committee having obtained pledges of $30,000 for the three years' work.

A gulf coast marine piling survey has just been started with E. E. Boehne, manager, sales, International Creosoting and Construction Co., as chairman of the committee. Finances have not yet been arranged for.

Effect of Perforations

As to the reduction in the strength of fir poles due to perforating to obtain an even penetration, a committee on the subject headed by L. L. Hill, secretary, Page & Hill Co., held that a deep and uniform penetration is of greater importance and will more than offset any reduction in strength. No one has yet been found to put up the $10,000 to $15,000 necessary to make the strength tests. Spreading of creosote from perforations in cedar poles after treatment takes place to an appreciable extent according to results reported by J. D. MacLean and C. E. Miller of the Forest Products Laboratory.

Dry heat obtained from the heating system of a building was reported by Walter H. Snell, department of botany, Brown University, Providence, R. I. as sufficient to kill certain "dry rot" species; destruction of the "mill roof" types, however, required higher temperatures.

None of the recommendations, including specifications for non-pressure or open-tank treatment, of the committee on preservatives could be accepted as standards because they had not been sent out 15 days previous to the meeting. Instructions were given to revise the definition and specifications of creosote to conform to modern practice, in which the origin as well as test limits of fractionation be given due consideration. Studies of sodium-flouride tests will be taken up.

Wood Block Paving

Specifications for flooring and street paving were submitted for information. Features in the paving block specification are the recommended cushions, mortar cushions, bituminous paint coat cushions and dry concrete too. Only bituminous fillers are noted.

Walter Buehler, engineer of wood preservation, the Barrett Co., explained the desirability of maintaining old wood block paving by an application of hot light oil, followed in 24 hours by a covering the chips. At this point A. E. Larkin, manager, Republic Creosoting Co., attempted unsuccessfully to reopen the age-old controversy relative to the merits of high-boiling and "adulterated" oils. "Explanations are of no use, a condition and not a theory confronts the engineer in charge of pavements," said Mr. Buehler. L. T. Ericson, chief engineer, Jennison-Wright Co., chairman of the paving and flooring committee, reported on the organization and preliminary work of the joint committee on wooden highway bridge design which has under consideration as its first problem the design of a more fire-resistant structure.

Nearly 300 members and guests registered at the convention. Next year's meeting will be held at New Orleans. It is proposed to increase the present membership of 407 to 1,000 during the year. The newly elected officers are as follows: President, F. J. Angier, vice presidents, W. H. Grady and H. S. Sackett; secretary-treasurer, George M. Hunt, Forest Products Laboratory, Madison, Wis.

Los Angeles Union Terminal P... Before Supreme Court

The California railroad commi... has extended the effective date of ... Los Angeles union terminal dec... pending action by the Supreme C... on an appeal for a writ of re... made by the Southern Pacific, ... Santa Fe and the Salt Lake Railro... Announcement of the commissi...'s decision appeared in *Engineering News-Record*, Dec. 22, 1921, p. 1039.

Federated Societies Plan Active Year

To Expand Work in Hand — Water Power Act and Patent Office to Receive Especial Attention

An indication of the faith which the Executive Board of the American Engineering Council has in the Federated American Engineering Societies was had at the recent meeting in Washington when a number of the representatives of member societies pledged that their organizations will refund to the Council the proposed discount on the assessment for 1922. (See *Engineering News-Record*, Jan. 12, p. 85.—Members of the Board and Council were outspoken in their endorsement of the work done during 1921. The intention to refund the discount is to enable the Federation to expand its activities.

In addition to the detailed accomplishments of the year, the opinion was expressed at the Council meeting that the 1921 work had crystallized the aims and purposes of the Federation to the point where much more in the way of concrete accomplishment may be expected in 1922.

During the coming year a study will be undertaken of the Water Power Act and its application, so that suggestions may be made as to its administration and amendments to the Act itself proposed if it should be decided that the fundamental law can be improved.

Work Contemplated

The Executive Board authorized the American Institute of Agricultural Engineers to conduct an investigation of waste in agriculture. The Federation expects to render active assistance in the study of intermittency in the coal industry, which is being undertaken under the immediate auspices of the Unemployment Conference.

Every resource of the Federation is to be brought to bear immediately in an effort to secure legislative relief for the Patent Office; to secure an embargo on dyes and to secure authorization for the appropriations to carry into effect the plan of the U. S. Geological Survey for the completion of the topographic map of the United States.

The principal accomplishments of the Federation during 1921 were cited as follows:

Elimination of waste report.

The securing of employment for 1,221 engineers during the first eleven months of 1921.

Securing the publication of over 500 articles pertaining to the activities of the society.

Legislative activities which involved at least a study of the following measures: the Patent Office relief; topographic map of the United States; commissioned status for sanitary engineers of the United States Public Health Service; Department of Public Welfare; cyclical depressions; Federal road act; waterpower act; Muscle Shoals project; reclassification and compensation of engineers in government service; tariff on petroleum; embargo on dyes; war minerals liberalization; Winslow refunding bill; Ladd metric system bill; forestry legislation; St. Lawrence waterway; Department of Public Works, and general executive reorganization.

Participation in such conferences as: Elimination of excess variety of paving brick; standardization of contracts and specifications in the construction industry; Fall letting of highway construction contracts; unemployment conference; census statistical conference; Board of Surveys and Maps.

Continued study of problems involved in the licensing of engineers and participation in hearings in a number of states.

Addresses before numerous engineering societies.

Stimulation of interest among engineers of foreign countries which has led to the formation of federations of engineering socities in six countries and paving the way for an international federation.

Study of continuous process industries.

Progress toward the more definite establishment in the public mind of the place and prominence of engineers in modern civilization.

Establishment in the minds of federal legislative and executive officials that they now have a definite point of contact with engineers as a whole.

Missed Shot on Hetch Hetchy Tunnel Kills Three

A drill struck a "missed shot" on Jan. 9 in Priest Portal of the Hetch Hetchy tunnel, which is being driven as part of the water supply project for San Francisco, and the resultant blast killed three men and injured four others.

The men were drilling at the heading, which is about 2½ mi. from the Portal when they struck a powder charge placed by the preceding shift but which had failed to explode. The men had been warned of the danger, according to other members of the shift, and were proceeding with caution when the accident occurred.

Asphalt Association Opens District Office in Atlanta

J. E. Pennybacker, secretary of the Asphalt Association, New York, announces the appointment of James R. Valk as district manager for the association with headquarters in Atlanta, Georgia. Mr. Valk has had a long experience in all phases of asphalt work. His attention will be devoted principally to Georgia, South Calorina and Florida, and he will co-operate closely with H. P. Grier who represents the association in North Carolina.

Arkansas Water-Power Plant Well Under Way

One of Largest Installations in Central Southwest Will Have Three 5,000-kw. Units

One of the largest hydro-electric plants in the central Southwest is now being built on the Little Red River, about 6 miles northwest of Judsonia, Ark. It is known as Plant No. 1 of the Arkansas Hydro-Electric Development Co. and will have a present installation of three 5,000 kw. units, with a final development of 70,000 hp.

The drainage area above this point is 1,400 square miles, about 40 per cent of which lies within the Ozark National Forest and 80 per cent of which is unfit for cultivation and likely to retain its forest cover for many years. The dam will be of the hollow concrete type, 825 ft. long at the gate crest and 80 ft. high. The average working head will be 70 ft. There will be fourteen Taintor gates 26 ft. wide by 18 ft. high with provision for 5-ft. flashboards. These flashboards will be used until additional storage is available from dams constructed above. The total usable storage about Dam No. 1 with flashboards is 7,000,000 K.W.H.

BEGINNING COFFERDAM ON LITTLE RED RIVER, ARK., FOR NEW WATER POWER PLANT

Construction was started last June and is expected to be finished next summer. Stone for the concrete is taken from a quarry adjacent to the site by a derrick and lifted to the platform above the rock crusher, after which it is elevated to a revolving screen. This screen separates two sizes of rock and sand. The tailings from the screen go back to a disc crusher which will make the sand to be used in the concrete. From this crusher, the sand is delivered to the same elevator and delivered to the sand bin. From the sand and stone bins, small cars will deliver this material to the bins above the one-yard concrete mixer passing under the plane of the two cableways which span the river.

From the cement house, which holds 60,000 bags, the cement is delivered by gravity to the platform above the concrete mixer. From this mixer, the concrete is delivered to buckets on cars which run by gravity back under the plane of the cableways on which they are carried to the point of deposit. It will require some 800 tons of reinforcing steel and 35,000 bbl. of cement for the dam and power house.

All rough lumber for buildings, cof-

ferdams and forms is obtained a short distance above the dam from timber in the basin and this is furnished by a sawmill which is moved from one timbered tract to another as required.

The contractor is J. Livingston & Co., Inc. of N. Y. The Engineers are Dickinson & Watkins, Little Rock. J. E. Sirrine & Co. of Greenville, S. C., are the consulting engineers.

New Jersey Highway Commission to Hold Convention

The second annual convention of the New Jersey State Highway Commission is to be held in Trenton, Feb. 15-18, inclusive. Invitation to attend the sessions is extended particularly to county and municipal officers, contractors, material men and equipment dealers.

Water Power League to Meet

The Water Power League of America is to hold a power conference at the Engineering Societies Building, New York City, Feb. 7 and 8. The main questions to be discussed are the proposed superpower system for New England and eastern United States, financing water-power projects independent of interests which now seem to control, the development of the St. Lawrence River, and the amendment of the Federal Power Act. The secretary of the League is Frederick L. Long, 116 Nassau St., New York City.

Civil Engineering Research To Be Developed

In order to promote research in civil engineering and the dissemination of knowledge of the results brought out by such research, the American Society of Civil Engineers has established a committee on research, organized under the chairmanship of Prof. A. N. Talbot, Urbana, Ill. It has also established an advisory committee on civil engineering to the National Research Council, Division of Engineering, at the request of Alfred D. Flinn, chairman of the division. The activities of this Advisory Committee will relate to such research problems in civil engineering as embrace several fields or organizations, and such problems of research in other fields as involve civil engineering and therefore require the co-operation of representatives of civil engineering.

The society's Committee on Research is expected to deal with problems of civil engineering research within the field of the society itself. Its appointment resulted from recognition of (1) the fact that the field of civil engineering contains many unsettled questions and presents new problems from day to day, many of which demand investigation by research; (2) the relative scarcity of research in this field and the desirability of promoting and stimulating it; and (3) the possibility of furthering the spread of knowledge of the results of research by establishing a central agency through which any required functions of counsel, organization, coordination, and publication can be dealt with. Prof. Talbot states that the committee hopes to interest the entire membership of the society in the need for and the value of research and adds that correspondence concerning the committee's work may be addressed to him or to the secretary, F. E. Schmitt, 10th Ave. at 36th St., New York.

New Texas Motor Vehicle Law Becomes Effective

According to the Johnson motor truck bill, which became effective in Texas Jan. 1, 1922, the annual license fees on commercial vehicles range from $30 on a 1½-ton truck to $150 on a 5-ton truck equipped with pneumatic tires, and from $36 to $180, respectively, for trucks with solid rubber tires. For trailers or semi-trailers equipped with pneumatic tires, the fee is to be 15 cents per hundred pounds of the net weight, plus the carrying capacity; and for trailers and semi-trailers equipped with solid tires, 25 cents per hundred pounds of the net weight, plus the carrying capacity. For those equipped with iron, steel or other hard-material wheels, the fee is to be 35 cents per hundred pounds of the net weight, plus the carrying capacity. Tractors will be registered at from $5 on tractors weighing 2,000 lb. or less, up to $25 for those weighing between 8,000 and 10,000 lb.

Owners of passenger vehicles are required to pay the regular 35 cents per horsepower rating, and $1 for each passenger the vehicle will seat in excess of seven. Trucks with a carrying capacity of one ton or less and all trucks used exclusively for agricultural purposes shall pay the regular 35 cents per horsepower rate and are subject to the same law which governs commercial vehicles. No motor vehicle with a greater carrying capacity than 8,000 lb. shall be registered without special permit.

Other features of the bill are that no motor vehicle equipped with solid rubber tires shall be operated upon the highways if the rubber is less than one inch thick; that the road superintendent is given authority to post notices stating the maximum load which can be carried over the road during wet weather or after recent construction, or when bridges or culverts are unsafe; that persons guilty of negligence that leads to highway's damage shall be liable to the county for such damages; and that all commercial motor vehicles, tractors and trailers shall register according to the manufacturers' rating.

New President of Engineering Institute of Canada

JOHN G. SULLIVAN

John G. Sullivan Head Canadian Engineers

Long Identified with Railway W... Now Consulting Engineer for Canadian Pacific Ry.

John G. Sullivan, who was elected president of The Engineering Institute of Canada for 1922 at the annual meeting held in Montreal, January 24 and 25, brings to the office the experience of thirty-four years spent in the West, combined with that spirit of optimism and enthusiasm which characterizes men of the western provinces.

Mr. Sullivan was born at Bushmills Basin, New York, January 11, 1863, and at the age of twenty-five was graduated from Cornell University with the degree of C.E. He then became associated with railway development in the West, at which he remained for years in many and varied capacities with the Great Northern Ry. in Montana, Dakota and Minnesota, and with the Spokane Falls and Northern Ry. Later he was associated with the Great Northern Ry. system in charge of work as assistant engineer on the Seattle and Montana Ry., and in charge of work on the Pacific extension of the Great Northern Ry. In 1893 Mr. Sullivan became assistant engineer in charge of work with the Alberta Ry. and Coal Co., and the following year locating engineer with the Butte, Anaconda and Pacific Ry. Co.

In 1895 Mr. Sullivan was made locating and division engineer with the Kaslo and Slocan Ry Co., British Columbia. For the next four years he occupied various positions with the Columbia and Western Ry. Co.

In August, 1900, Mr. Sullivan joined the Canadian Pacific Ry. as divisional engineer of construction, and with the exception of a year and a half as assistant chief engineer of the Panama Canal, his association with the Canadian Pacific Ry. has been continuous up to the present time. In February, 1907, Mr. Sullivan was made manager of construction of Eastern Lines, and a year and a half later was appointed assistant chief engineer. In 1911 he became chief engineer of Western Lines, occupying that position and that of chief engineer up to 1918, since which time he has been retained as consulting engineer.

His previous association as an officer of the Institute includes councillor on two different occasions, and vice-president. Mr. Sullivan became a member of the Institute in 1900, having been elected a member of the American Society of Civil Engineers the year before. In 1918 he was president of the American Railway Engineering Association and is the chairman of the Manitoba Drainage Commission. He is a member of the Manitoba and St. Charles Country Clubs, Winnipeg, St. James Club, Montreal, and Cornell University Club, New York City.

International Railway Association to Meet in Rome

The International Railway Association is to resume its triennial meetings, which were omitted during the period of the war. The next session will be at Rome, Italy, from April 18-30, 1922. The secretary of the Permanent Commission of the Association is J. Verdeyen, 17 Rue de Louvain, Brussels, Belgium.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Convention, Cleveland, Ohio, Feb. 13-16.
AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago; Annual Convention, Chicago, March 14-16.
AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Philadelphia, May 15-19.

The **National Highway Traffic Association** will hold a public meeting on Feb. 14 at 8 p. m. at the Automobile Club of America, New York City. The subjects for discussion are: Adequate Parking Facilities for Passenger and Commercial Motor Vehicles; Segregation of Slow Moving Traffic and Relief Measures for Terminal and Ferry Congestion. Dinner will be served at the club at 6:30. Reservations can be made through the secretary of the Automobile Club.

The Topeka Engineers' Club held its annual meeting and banquet on Jan. 24. Officers were elected for 1922 as follows: President, A. B. Griggs; first vice-president, F. W. Epps; second vice-president, Ray Finney; secretary W. L. Lammers; treasurer C. A. Funchess.

The New York Section Am. Soc. C. E. at its February 15 meeting will discuss the "Removal of Solid Wastes." The opening address will be by John P. Leo, Commissioner of Street Cleaning, New York City.

The Rochester Engineering Post, American Legion at a recent meeting elected officers for 1922. President, Ray M. Robinson; first vice-president, Allen Martin; second vice-president, Harold B. McElwain; secretary, George Strickland; treasurer, Clayton Hutchins.

The New Jersey Sewage Works Association will hold its annual meeting on Feb. 17 at 10 a. m. in the State House, Trenton, N. J.

The Engineering Society of Buffalo will hold its regular monthly meeting Feb. 14. Ralph H. McKee, professor of chemical engineering, Columbia University will deliver an address on "Gasolene from Oil Shale."

PERSONAL NOTES

CHARLES COSTIGAN, formerly county engineer of Summit County, Ohio, has become a member of the new Metropolitan Construction Co. in Columbus. The firm will specialize in bridge and road construction.

W. J. H. FOGELSTROM and H. V. JOHNSTON have opened offices in San Francisco for the practice of engineering. Mr. Fogelstrom was formerly structural engineer for the Southern Pacific Co., the Atchison, Topeka & Santa Fe Railway Co. and the Alaska Government Railway. Mr. Johnston was assistant engineer for the California Railroad Commission and chief engineer for the Sacramento Valley West Side Canal Co.

JOSEPH M. TRACY has resigned as city engineer of Ogden, Utah and W. S. Craven has been appointed to take his place.

H. R. F. HELLAND, for the past two years city engineer of Waxahachie, Texas, has entered an engineering partnership with his father, Hans Helland, who was formerly city engineer of San Antonio, where the firm has its offices. Mr. Helland was in France for a year during the war and was Commissioned Captain of Engineers.

OSCAR A. PIPER, who has been connected with the Seattle city engineer's department since 1908, with the exception of two years spent in the army during the war, has been appointed superintendent of streets and sewers for the city of Seattle.

HARRY A. KLUEGEL, until recently construction engineer in the Quartermaster corps, U. S. A., has been named chief of the division of water rights for the state of California.

HON. WILLIAM C. KENNEDY, gas and oil operator of Windsor, Ont., has been appointed minister of railways and canals for Canada.

JAMES COSTELLO has been appointed division superintendent in the county road department, Allegheny County, Pa.

FRANK C. LINGENFELTER, city engineer of Indianapolis, has resigned after serving in the city engineer's office in various positions for fifteen years.

H. W. MIXSELL, formerly construction engineer for the Bath Portland Cement Co., Bath, Pa., has been appointed town engineer of Phillipsburg, N. J., succeeding C. J. Tilton, resigned.

VICTOR H. COCHRANE, formerly of Hedrick & Cochrane, Kansas City, Mo., has resumed his practice as consulting engineer, in Tulsa, Oklahoma.

GERMAIN P. GRAHAM, former deputy city engineer of Albany, N. Y., has been appointed district engineer for the Asphalt Association in New York, Quebec and Ontario.

COL. JAMES W. EVERINGTON, U. S. A., retired, has been appointed chief of police of the city of Los Angeles, Cal. Col. Everington was formerly engineer of maintenance for the Great Northern Railway.

A. G. HUSTED has resigned as assistant sanitary engineer with the department of public service of the city of Cleveland, Ohio, to become assistant sanitary engineer of the sanitary engineering district of Cuyahoga County, Ohio.

G. N. MITCHAM, division engineer, state highway department of Alabama, has been elected president of the Montgomery chapter, A. A. E.

CLINTON R. GOODRICH has been made commissioner of public works by the recently inaugurated mayor of Utica, N. Y. Mr. Goodrich is a graduate in civil engineering, Cornell University, class of 1905, and ever since his graduation has been engaged in engineering work. His early experience was in railroad work in the Middle West and South. Later he was connected with power house work around Albany and with the construction of the Barge Canal from the contracting end. He has also had experience in mining in the Southwest and as a construction superintendent for James Stewart & Co. in the Middle West and Southwest. For the last six years he has been with the Vale Engineering Co. of Utica, engaged in the design and construction of reinforced-concrete buildings and the construction of concrete roads.

JOHN L. STANAGE, engineer and contractor, Milwaukee, Wis., has opened engineering offices in Oconomowoc, Wis.

CONRAD HANSON has been appointed highway commissioner for Douglas County, Wis., succeeding C. D. Conker, Jr., who has resigned to enter private practice in Los Angeles, Cal.

HARRY S. WRIGHT, formerly field superintendent with the Aberthaw Construction Co., has become associated with the Portland Cement Association as structural engineer covering the New England territory and having headquarters in Boston.

A. E. DOUCET, director of public works, Montreal, Quebec, has resigned, effective Feb. 1.

W. L. MCDOUGALD of Montreal, director of the Canadian Steamship Lines and president of the Ogdensburg Coal and Towing Co., has been appointed chairman of the harbor commission of Montreal.

CHARLES W. SPOONER, consulting valuation engineer, and ROBERT W. MERRILL have organized the firm of Spooner & Merrill, consulting engineers, with offices in Grand Rapids, Mich. Mr. Merrill has recently returned from a 3-year engagement in China at work on the Grand Canal under Joseph Ripley, chief engineer of the Grand Canal Improvement Board, and Col. Thomas H. Wiggin, in charge of canal structures.

BUSINESS NOTES

ROYALL D. BRADBURY has become associated with the Wickwire Spencer Steel Corporation as sales manager of the structural products department with headquarters in the Worcester office. Mr. Bradbury was formerly instructor in structural engineering in the Massachusetts Institute of Technology, afterward becoming connected with the Clinton Wire Cloth Co. as consulting engineer and later as vice-president of that company.

GEORGE P. SHUTE, manager of the Portsmouth (Ohio) water-works, has resigned to become general manager of the Shute Co., of Columbus, Ohio, mining and manufacturing clay products.

C. I. MILLARD has resigned as president of the John L. Roper Lumber Co., Norfolk, Va., to accept the presidency of the Chicago Lumber & Coal Co. with headquarters at St. Louis, Mo. Mr. Millard has been the head of the Roper Co. for the past twelve years and was vice-president of the Norfolk Southern Railroad during the period of Federal control.

Business Side of Construction

Facts and Events that Affect Cost and Volume

January Contracts Have Value of $88,584,166

Represent Double the Volume for Same Month of 1921—Road Work Continues Active

Contracts let for January, 1922, as reported to *Engineering News-Record* was $88,584,166. This figure includes

Large Contracts Let

Among this week's announcements of contracts awarded in Construction News, pp. 41-50 are the following large projects: A hospital in New York City to G. R. Davis, 30 East 42nd St., $1,500,000; an 8-story cold storage and ice plant in Kansas City, Mo., to E. W. Sproul & Co., 39th and Robey Sts., Chicago, $1,000,000.

Cement Prices Adjusted Downward in 15 Cities

Competition and Removal of Tax Lowers Prices—Mill Prices Not Affected

Meeting competition and the removal of the 3 per cent transportation tax on Jan. 1 have caused cement prices

Engineering News-Record Construction Cost Index Number

February, 1922	**168.72**
December, 1921	167.82
January, 1921	230.87
Peak, June, 1920	273.80
1913	100.00

Engineering News-Record's Construction Cost Index Number is exactly the same as last month. The New York pine base remains $49 to contractors. Structural steel shapes have stood at $1.50 since Nov. 1. A number of cement price revisions are reported on this page, but the Chicago quotation is still $1.97. There have been certain wage adjustments, but the average common labor rate for the country remains at 45c. per hour. Thus, general construction cost is 26 per cent cheaper than one year ago and 38 per cent under the peak; it is 69 per cent above the 1913 level.

Engineering News-Record Construction Volume Index Number

Monthly	
January, 1922	**91**
December, 1921	118
January, 1921	41
1913	100
Yearly	
1921 (entire year)	88
1920 (entire year)	91
1913	100

Engineering News-Record's Construction Volume Index Number is 91 for the month of January, and 88 for the whole of 1921, as against 100 for 1913. This means that the actual volume of construction in 1921 (not the mere money value of the contracts let that year) is 12 per cent under the volume of construction for 1913. Our monthly volume number, 91 for January, 1922, is really the increment of construction, and indicates the rate at which contracts are being let as compared with 1913 awards.

no residential building nor any housing except that for industrial uses. The total also represents about double the volume of building put under contract in January, 1921, and approximately 65 per cent of the volume of construction put under contract for January, 1920.

As seen in the accompanying table, all classes of construction reported fair averages for January, 1922, as compared with the preceding year. In only two classes of construction—sewers and federal government work—were the actual figures of 1921 larger than those of 1922. There was considerable increase in industrial construction reported over the last months

COMPARISON OF VALUES OF CONTRACTS LET FOR JANUARY 1920, 1921 AND 1922

Classification	1920	1921	1922
Waterworks	$1,143,777	$519,028	$1,727,136
Sewers	1,863,840	3,146,948	2,267,053
Bridges	2,021,553	3,030,477	3,148,793
Excavation, dredging	1,541,576	1,266,346	2,090,979
Streets, roads	12,203,970	11,597,810	15,126,386
Industrial	56,041,047	12,881,968	18,178,470
Buildings	87,095,987	17,455,673	36,354,079
Federal Government	4,980,945	2,071,141	1,186,673
Miscellaneous	8,256,071	2,358,976	8,504,597
Total	**$175,148,766**	**$54,328,367**	**$88,584,166**

of 1921 as well as over the corresponding month of 1921, but this was due largely to putting under contract several large hydro-electric projects.

E. N.-R. Cost Index Number Revised for 1914

Reconsideration of the steel situation in 1914 has led to the conclusion that the prices of structural shapes used in computing the *Engineering News-Record* Construction Cost Index Number were too high, and the index number based upon them correspondingly too high. The iron and steel market in this first year of the war was uncertain; it was not yet realized how the war would boom the industry. Taking prices more nearly in line with actual domestic selling gives the following values:

1914	Cost Index Number
January	89.22
February	89.22
March	88.97
April	87.97
May	88.62
June	87.87
July	88.12
August	90.11
September	90.36
October	88.51
November	87.26
December	86.51

The above values are to be taken as the official Cost Index numbers for the months of 1914, and should be substituted for the values previously published for that year.

The complete list of index numbers will be reprinted in July.

to settle downward from 1 to 20 cents per bbl. A drop of 2c. is reported in Philadelphia, Boston, Cleveland, Indianapolis, Cedar Rapids, Minneapolis and Cincinnati, and a 1c. decrease in Milwaukee, Peoria and Davenport. The greatest decline was in Denver, from $3.10 to $2.90. Other reductions are 14c. in Detroit, 11c. in Toledo, 16c. in Seattle, 5c. in Kansas City. Mill quotations did not fluctuate in the last month. The regular monthly list of current prices, compared with month-ago and year-ago figures, will be found on p. 218 of this issue.

Bids Wanted on Big Jobs

Among the projects on which bids are either asked or will soon be called in Construction News, pp. 41-50 are the following:

A theatre and store in New York City, $1,000,000.

An office building in Kansas City, Mo., $2,500,000.

A street and road project at Chicago, Ill., $7,000,000.

A bank and office building at Pittsburgh, Pa., $5,000,000.

Next Week—Production and Stocks of Construction Materials in the United States.

Wages and Hours of Labor Since 1914

According to a digest of its comprehensive report upon industrial conditions in the United States, the National Industrial Conference Board sets forth the following facts:

The composite hourly earnings of all wage earners (approximately 1,250,000 investigated) increased 156 per cent between July, 1914, and September, 1920. The decline from that period to the middle of 1921 amounted to 16.5 per cent.

The decline from the peak to July, 1921, for common labor was 17.3 per cent and for skilled labor, 15.2 per cent. The percentages of increase in June, 1921, over 1914 were 117 per cent for common labor and 111 per cent for skilled labor.

The composite weekly earnings of all wage earners increased 140 per cent between July, 1914, and July, 1920. The peak weekly earnings averaged $29.81. The decline from the peak to July, 1921, amounted to 23.2 per cent, leaving a net increase of 85 per cent over July, 1914, the money decrease being $6.91.

The composite weekly earnings of common labor increased 149 per cent between July, 1914, and July, 1920, and the composite weekly earnings of skilled labor showed an increase of 137 per cent for the same period. Percentages of decline from the peak were for common labor, 25.8 per cent and for skilled labor, 22.8 per cent.

The actual week per wage earner in all industries shows a decline from 51.1 hr. in July, 1914, to 48.9 hr. in June, 1920.

The beginning of 1921 marked a reduction to 44.1 hr. per week and the depression period occurred in April of 43.6 hr. In June, 1921, the average wage earner was working exactly 5 hr. less than in the preceding June, thus constituting a loss of approximately 10.2 per cent in working hours.

Union Pacific Places $9,000,000 Car Order

Recent reports are to the effect that the Union Pacific system has placed an order with car builders calling for 4,500 specially constructed freight cars, the total cost to be between $9,000,000 and $10,000,000. The cars are expected to be available for use in the early summer.

Labor Rates and Conditions Throughout the Country

Actual changes in labor rates have occurred in seven of the twenty-one cities reporting. The Impartial Wage Board of San Francisco has standardized the building trades wage scale for that city and will keep the present schedule in effect until Dec. 31, 1922. This board has taken into consideration the fact that while a craftsman must be paid in accordance with his skill and the amount of risk involved, his employment is not continuous and that drastic wage reductions will net him an annual income entirely disproportionate to the cost of living. Bricklayers and structural iron-workers have been reduced from $1.16 to $1.12½; carpenters, hoisting engineers and pile-drivers from $1.03 to $1 per hr. Skilled laborers receive 62½c., and common laborers 45c.@56¼c. per hr. for a 6-day week.

Bricklayers have been reduced from $1.12½ to 95c. in Cincinnati; hod-carriers from 87½c. to 85c. in St. Louis and structural iron-workers from 55c. to 50c. per hr. in Montreal.

Pick and shovel men in New York City are quoted at 60c. as against 75c. per hr., or $4.80 per 8-hr. day, at excavating work.

Twenty-six communities were represented at a convention of the Minnesota Building Employers' Association in Minneapolis recently. The Association instituted a 20 per cent wage reduction last Spring, which has applied to the bulk of building construction in the state since. It was decided to keep the current wage scale in force through 1922.

On Jan. 23 the New Orleans Association of Commerce opened an organized campaign to register all unemployed persons in the city. One purpose is to learn how many of those registering belong to the migratory element which comes South during the winter months, thereby taxing the resources of the local charitable organizations.

Los Angeles reports considerable unemployment among unskilled laborers due principally to the same condition that effects New Orleans: the influx of transients from the colder sections of the country.

Building construction is practically at a standstill in both Denver and St. Louis. In Denver the shutdown is mostly seasonal and local contractors are preparing for the resumption of Spring building activities of considerable proportions. In St. Louis the Building Trades' Council and the Master Builders' Association are arbitrating the proposed wage reduction, without having yet reached an agreement.

Cincinnati reports 28,000 unemployed. The skilled building trades mechanics, however, do not comprise a very large percentage of this total.

The wages of five building trades have been determined by the Builders' Exchange of Syracuse and seven more are under arbitration. Hod-carriers and building laborers now receive 30@50c. per hr. Bricklayers still receive $1.12½; painters 90c. and sheet-metal workers $1 per hr. These three trades have thus far successfully resisted reduction. Lathers and plumbers receiving $1 per hr., have not yet been asked to accept a cut. Electrical workers demand renewal of $1 per hour agreement.

Labor plentiful, all classes.—Higher rates indicated by +, decreases by—

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$0.90	$0.70	$1.00	$0.30	.....	$1.00	$0.20
Baltimore	1.25	.80	.87½	.54	$0.74	1.00	.30
Birmingham	1.00	.75	.....	.25	.....	1.00	.15@.25
Boston	.90	.75	.90	.60	.90	.90	.40
Cincinnati	0.95	.87½	.87½	.72½	.77½	.77½	.37½
Chicago	1.10	1.00	1.10	.....	.....	1.05	.35@.40
Cleveland	1.04	1.04	1.04	.60	.91	1.04	.57½
Dallas	1.00	1.00	1.00	.60	1.00	1.00	.35@.45
Denver	1.37½	1.00	1.00	.75@.81¼	1.00	1.00	.35@.40
Detroit	1.00	.80	80@.90	50@.60	1.00	.60@.80	.50
Kansas City	1.07½	1.00	1.00	.80	1.07½	1.07½	.70
Los Angeles	1.25	1.00	1.00	1.12½	.87½	1.00	.50@.56¼
Minneapolis	1.00	.80	.80	.65	.....	.80	—.40
Montreal	.80	.60	.50	.30	.50	—.50	—.20@.30
New Orleans	1.00	.88	.90	.40	.80	1.00	.30
New York	1.25	1.12½	1.25	.87½	1.00	1.12½	—.60
Pittsburgh	1.12½	1.00	1.00	.80	.....	1.00	.40@.45
St. Louis	1.25	1.25	—1.25@1.37½	—.85	1.25	1.25	.67½
San Francisco	—1.12½	—1.00	—1.00	—.75	—1.00	—1.12½	.45@.56¼
Seattle	1.00	.80	.90	.70	1.00	.80@.90	.50
Philadelphia	1.00	.90	.90	.75@90	1.00	.90	.....

Oklahoma Cement Makers Ordered To Sell Direct to Users

Acting upon a complaint filed in July, 1921, by the secretary of the Oklahoma Chapter of the Associated General Contractors of America, the Corporation Commission of Oklahoma recently ordered the cement manufacturers of the state to sell cement, when ordered in carload lots, direct to any department of the state, any municipality or any general contractor or other user of cement willing to pay cash, at the same price as quoted to dealers. The practice in the past has been to add to the mill price a distributing agent's commission fee.

The complaint was filed with the Corporation Commission of Oklahoma by R. G. Marriott, the specific respondents being the Oklahoma Portland Cement Co. and the Dewey Portland Cement Co. manufacturing in Ada and Dewey, Okla., respectively. The complaint cited the fact that the 1910 revised laws of Oklahoma ordered that a public business be subject to control by the state, by the Corporation Commission or by an action in any district court of the state as to its practices, rates and charges. The decision rendered by the Corporation Commission defined cement manufacturing as a "public business," as set forth in the 1910 statute. The specific charge was made in the hearing that members of cement mills were refusing to sell their product in carload lots direct to contractors for either private use or use in construction of improvements undertaken by the state or other municipal subdivisions, requiring that the cement be handled through local distributors regardless of the service, if any, rendered by them.

The order, therefore, robs the practice of selling cement of all discriminatory features. When cement from mill is available a commission acts.

Trend of Business

Foreign Exchange—On Jan. 30 sterling moved to $4 28½, highest since August, 1919. This was a rise of 4c. in one day, and was 18c. above the lowest January quotation. Sterling was at $3.18 in February, 1920. Canadian dollar at 95.4 on Jan. 28. Other European exchanges higher.

Exports to Europe last year were $2,300,000,000 less than for 1920, and to South America $300,000,000 less.

Money—Call loan rate 5½ per cent. Time loans at 4¾@5.

Car Surplus for period ending Jan. 15 was 439,982 cars, a decrease of 53,375 cars since Jan. 8. Of this decrease 18,749 cars were box, and 24,160 gondolas. This is the first decrease effected in surplus cars since the week of Oct. 31, 1921. Total revenue freight loaded in the week ended Jan. 14 was 720,877 cars, an increase of 114,885 cars over the total of the previous week. Compared with the same week of a year ago, however, the increase was but 5,022 cars.

Lumber Demand Picking Up Through Country

Contrary to reports emanating from eastern financial circles to the effect that reduced rail rates on lumber had retarded the movement, a continuing recovery in demand is shown as the outstanding feature of the second week in January, according to the statistics collected by the American Wholesale Lumber Association. Reports from various reporting associations indicate production, shipment and orders all picking up, with orders 98 per cent of production, although the demand is still 26 per cent below normal.

A. Fletcher Marsh, statistician of the association, says: Yellow pine has shown a steady increase in demand for both weeks in January, in fact for the second week of the month demand exceeded even production, so that shipments which had not been showing such a rapid increase will probably pick up in the next report. Pine is still in heavier demand than fir, and so far this year has appeared in a healthier condition. The North Pacific Coast, he reports, is still being hindered with bad storms and hard weather, in spite of which production and shipments are increasing, and orders picked up from the slump which they experienced the first week of the year. Rail business took a decided jump in volume, having been 1,408 carloads for the week of Jan. 14 as compared to 940 for the previous week. This would indicate that the rail business is at present the sustaining feature of the West Coast, whereas in the past the export business has been the mainstay.

Monthly Prices of Construction Materials

Ups and Downs of the Market

Pig Iron—Eastern Pa., No. 2x, quoted at $22.26 one month ago, dropped to $20.76 on Jan. 20, 1922 and returned one week later to the current price of $22.26 per gross ton, delivered, in Philadelphia.

Railway Supplies—Light rail, 25 to 45 lb., quoted at $30@$36 as against $31@$32 per ton f.o.b. Pittsburgh. Reduction quoted on standard spikes at the Birmingham mills and on track bolts at Pittsburgh. Advance in price of standard spikes at Pittsburgh and on track bolts and standard section angle bars at Birmingham.

Pipe—Slight advance quoted on cast-iron pipe in Birmingham and a decline in Chicago. Clay drain tile, 6-in., quoted in New York at $100 per 1,000 lin.ft.; 8-in. at $150, as against $105 for 6-in. and $175 per 1,000 ft. for 8-in. Slight drop in sewer pipe, all sizes, in Philadelphia; price stable elsewhere.

Road and Paving Materials—Average drop of ½c. per gal. quoted on road oils in New York. Asphalt in bulk down $1 in New York and $1 per ton both in packages and in bulk in St. Louis. Dressed paving stone up 5c. and wood block paving down 70c. per sq.yd. in St. Louis.

Sand, Gravel and Crushed Stone—Gravel ¾-in. up 20c. per ton in St. Louis. Sand down 3c. per ton in Birmingham and 20c. per cu.yd. in Philadelphia. Crushed stone quoted at $1.75@$1.85 as against $1.80@$1.90 in New York; and $1.65@$2 as compared with $1.65 one month ago in St. Louis and down 65c. per cu.yd. in Kansas City.

Lime and Cement—Hydrated finishing lime quoted in New York at $16.80 as against $16.99 per ton; common lump lime at $3@$3.48 as compared with $3@$3.49 per bbl. (280-lb. net) one month ago. Slight decline due to the removal of 3 per cent war tax on transportation, which became effective with January. Common lump lime down 15c. in San Francisco; lump finishing lime down 25c. per bbl. in Seattle and hydrated finishing lime up $5 per ton in Montreal.

Cement—Net price f.o.b. in Detroit, $2.17, as against $2.31; Toledo $2.20 instead of $2.31; Denver $2.90 as against $3.10; in Seattle at $2.94 reduced from $3.10 and in Kansas City at $2.40 as compared with $2.45 per bbl. one month ago. Current quotations in New York are $2.20@$2.30 as against $2.30 per bbl., delivered.

Structural Material—Reduction in triangle mesh in New York and Chicago; mill prices firm. Steel shapes, plates and bars down 15c. in New York; bars down 15c. and shapes 25c. in Chicago; bars down 25c., shapes 35c. and structural rivets $1 per 100 lb. in San Francisco.

Roofing Materials—Tar felt reduced 15c. per roll f.o.b. New York; asphalt felt down $5 per ton at plant.

Brick and Hollow Tile—Common brick declined $2 in Cincinnati; $1.50 in New Orleans; $1 in Birmingham and advanced $2 per 1,000 in New York and Detroit. Fairly active demand and an open winter have diminished the winter reserves in New York. While no actual shortage exists supply is sufficient to meet building requirements for the present time only. Reductions in hollow tile in Phila. and St. Louis.

Lumber—Long leaf yellow pine advanced $1 on all sizes in Chicago; declines ranging from $1 to $5 per M ft. reported in Kansas City, Philadelphia and Atlanta. Average rise of $2 per M ft. on Douglas fir in Seattle, Kansas City and Minneapolis; down from $1 to $5 in Los Angeles, Denver and Philadelphia. Hemlock and spruce also down in Los Angeles and Philadelphia.

Rope—Discounts increased on all regular grades of bright and galvanized wire rope. Manila rope up 1c. in Kansas City and St. Louis; 1½c. in Detroit; 2c. in Denver and 3c. in Cincinnati; down 1c. per lb. in Seattle.

Explosives—Price of 40 per cent and 60 per cent gelatin dynamite advanced in Cincinnati and St. Louis; declined in Kansas City.

Linseed Oil—Rise in price of flax seed reflected in advance of 5c. on linseed oil in New York and 6c. per gal. in Chicago.

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton—Quotations compiled by The Matthew Addy Co.:

	Current	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25 @ 2.75)	$22.50†	$38.50
Southern Basic	22.02†	34.50
Southern Ohio No. 2 (silicon 1.75 @ 2.25)	23.52†	34.00
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25 @ 2.75)	28.50†	44.26
BIRMINGHAM		
No. 2 Foundry (silicon 2.25 @ 2.75)	18.00†	34.00
PHILADELPHIA		
Eastern Pa., No. 2X, (2.25@2.75 sil.)	22.26†	36.00*
Virginia No. 2 (silicon 2.25 @ 2.75)	28.74†	40.00*
Basic	20.75†	34.00†
Coke Forge	22.50†	34.00*
CHICAGO		
No. 2 Foundry Local (silicon 1.75 @ 2.25)	21.70†	35.00
No. 2 Foundry Southern (silicon 2.25 @ 2.75)	24.66†	40.60
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley (silicon 1.75 @ 2.25)	22.46†	36.96
Basic	20.96†	31.96
Bessemer	21.96†	33.96

*f.o.b. furnace. † Delivered.

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh			
	Current	One Year Ago	Birmingham	Chicago
Standard bessemer rails	$40.00	$45.00		$40.00
Standard openhearth rails	40.00	47.00	$40.00	40.00
Light rails, 8 to 10 lb.	**1.55***	2.45@3.00*	1.60*	1.65@1.80*
Light rails, 12 to 14 lb.	**1.55***	2.41@2.95*	1.60*	1.65@1.80*
Light rails, 25 to 45 lb.	**30.00@36.00**	2.32@2.85*	1.60*	1.65@1.80*
Rerolled Rails	1.45	1.50*		

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, White Oak	$1.35	$1.50
Chicago, Hardwood and Red Oak	1.20	1.30
Chicago, Empty Cell Creosoting (add'l)	.45	.50
San Francisco, Green Douglas Fir	.75	.97
San Francisco, Empty Cell Creosoted Douglas Fir	1.70	2.20

For ties on standard "railroad administration" specifications, f.o.b. cars, St. Louis:

	White Oak	Red Oak	Pine and Sap Cypress
Grade 3	$1.15	$1.05	$0.95
Grade 2	1.05	.95	.85
Grade 1	.95	.85	.75

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	Current	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	**$2.30@2.35**	$3.65@3.90	$2.65	$3.60	*$4.25*	*$3.75*
Track bolts	*3.00@3.25*	5.50@6.00	3.65	4.60	*5.25*	**4.60**
Standard section angle bars	2.40	2.75@3.75	2.40	3.25	4.00	**3.45**

PIPE

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
⅛ to 3	71	58½	¼ to 1¼	44½	29½

LAP WELD

2	64	51½	2	39½	25½
2½ to 6	68	55½	2½ to 6	42½	29½
7 to 8	65	51½	7 to 12	40½	27½
9 to 12	64	50½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

⅛ to 1¼	69	57½	¼ to 1½	44½	30½
2 to 3	70	58½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	62	50½	2	40½	27½
2½ to 4	66	54½	2½ to 4	43½	31½
4½ to 6	65	53½	4½ to 6	42½	30½
7 to 8	61	47½	7 to 8	35½	23½
9 to 12	55	41½	9 to 12	30½	18½

STEEL—From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
⅛ to 3 in. butt welded	66%	60%	56½%
2½ to 6 in. lap welded	61%	57%	53½%

	Galvanized		
	New York	Chicago	St. Louis
⅛ to 3 in. butt welded	53%	46%	42½%
2½ to 6 in. lap welded	47%	43%	39½%

Malleable fittings, Class B and C, from New York stock sell at list less 10%. Cast iron, standard sizes, 35-5% off

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	New York					
	Current	One Year Ago	Birmingham	Chicago	St. Louis	San Francisco
4 in.	$50.30	$73.30	**$42.00**	*$44.60@$46.60*	$46.20	$54.00
6 in. and over	47.30@48	30 63.30	$35@**36.50**	*40.60@42.60*	43.20	50.00

Gas pipe and Class "A," $4 per ton extra; 16-ft. lengths, $1 per ton.

CLAY DRAIN TILE—The following prices are per 1000 lin.ft.:

	New York					
Size, In.	Current	One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	$40.00	$62.00	$35.00	$50.00		$55.00
4	50.00	77.50	85.00	60.00	$90.00	65.00
5	80.00	110.00	140.00	80.00	115.00	84.00
6	*100.00*	140.00	140.00	100.00	150.00	110.00
8	*150.00*	228.00	200.00	150.00	250.00	181.00

SEWER PIPE—The following prices are in cents per foot for carload lots f.o.b.

Size, In	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	$0.14	$0.087		$0.0875	$0.12	$0.12	
4	14	087	$0.09	0875	12	15	$0.18
5	21	1305		1225	18	18	165
6	21	1305	135	1225	18	21	25
8	35	203	225	20	28	30	33
10	52	3045			42	42	
12	67	3915	3825	36	54	54	80
15	1.15	522	5625	..	72	90	..
18	1.55	725	765	..	1.00	1.32	..
20	1.98	87	1.125		1.20		..
22	2.64	1.16			1.60		..
24	2.97	1.305	1.4625	1.20	1.80	2.16	2.40
27	4.50	1.885			3.75	3.00	..
30	5.00	2.088	3.20		4.75	3.60	..
33	6.55	2.61			5.50		..
36	7.50	2.9725	..	3.65	6.00	..	..
		3	5	8	12	24	36
Boston	$0.108	$0.162	$0.252	$0.486	$1.62	$4.92	
Minneapolis	..	..	40	77	2.55	5.66	
Denver	..	15	30	50	1.95	..	
Seattle	145	..	36	72	2.59	..	
Los Angeles	11*	165*	275	495	1.65	..	
New Orleans	..	108	27	459	1.755	..	
Cincinnati	10	15	233	45	1.50	4.305	
Atlanta	098*	147*	245	4165	1.5925		
Montreal, *delivered*	30*	45*	70*	1.35	4.50	6.50	
Detroit	105	1575	245	4725	2.115	5.4325	
Baltimore	1225	2275	35	6875	2.29	5.25	
Kansas City, Mo	15*	21*	335	60	2.41	4.74	
Philadelphia	*087*	*14*	*20*	*3925*	*1.306*	*1.65*	

*4-in., 6-in., 9-in., respectively

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8,000 gal. minimum f.o.b. place named:

		Current	One Year Ago
New York, 45% asphalt	(at terminal)	$0.05½	$0.10
New York, 65% asphalt	(at terminal)	*.05*	.08
New York, binder	(at terminal)	*.06½*	.09
New York, flux	(at terminal)	*.05½*	.08½
New York, liquid asphalt	(at terminal)	*.06*	.10
St. Louis, 50-60% asphalt	(*f.o.b.*) *Tulsa, Okla.*	.01½*	.11
Chicago, 40-50% asphalt		.05	.08½
Chicago, 60-70% asphalt		.05½	.08½
Dallas, 40-50% asphalt		.10	.10
Dallas, 60-70% asphalt		.13	.13
Dallas, 75-90% asphalt		.15	.15
San Francisco, binder, per ton		*13.00*†	15.00

* Freight $21.75 per ton to Whiting, Ind.
† F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

ASPHALT—Price per ton in packages (350-lb. bbl., or 425-lb. drums) and in bulk in carload lots:

	Package	Bulk
New York (Bayonne, N. J.)	$25.00	*$15.00*
Boston	No quotations	
Chicago	25.85	19.50
San Francisco *f.o.b. refinery*, Oleum, Cal.	*19.50**	*13.00**
Dallas	35.00	27.00
Seattle	*25.50*	29.40
Denver	45.00	65.00 *
Minneapolis	....	20.50
St. Louis	*25.00*	*19.00*
Baltimore	25.00	20.00
Los Angeles, *f.o.b. dock*	22.50	15.00
Montreal	28.00	21.00
Atlanta	*27.00*	....
Detroit (Petroleum asphalt)	24.50	20.00
Cincinnati	26.10	21.80
Maurer, N. J. (natural asphalt)	36.00	33.00
Maurer, N. J. (artificial asphalt)	22.00	20.00
Philadelphia	24.00	17.00
Kansas City	28.83	22.83

*Freight to San Francisco, 80c. per ton.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums. Rebates of about $1 per bbl., no rebate for drums.

PAVING STONE—

New York	5-in. granite, 28@29 blocks per sq.yd.	$130.00 per M	
Chicago	About 4x8x4 dressed	3.35	sq.yd.
	About 4x8x4 common	3.00	sq.yd.
San Francisco	Basalt block 4x7x8	65.00 per M	
Boston	5-in. granite	125.00 per M	
Atlanta	Granite	2.00	sq.yd.
Detroit	Granite, 26½ blocks per sq.yd.	107.00 per M	
Baltimore	Granite	2.00	sq.yd.
Montreal	Granite	125.00 per M	
New Orleans	Granite, 4 x 8 x 4	3.25	sq.yd.
Cincinnati	Granite	4.30	sq.yd.
St. Louis	4x8x4 dressed	3.35	sq.yd.
	4x8x4 common	2.95	sq.yd.
Kansas City	No. Granite	3.95	sq.yd.
Philadelphia	Granite	125.00 per M.	

FLAGGING—

New York	Bronx	$0.25	sq.ft.
	Manhattan, 4 ft.	.26	sq.ft.
	Queens, 5 ft.	.26	sq.ft.
	6x20-in. cross-walk	1.00	lin.ft.
Chicago	18 in. wide	.99	lin.ft.

CURBING—Bluestone per lineal foot, in New York, costs 77c. for 5x16 in., 88c. for 5x18 in.; in cargo lots.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2.09
New York	3½	16	2.17
New York	4	16	2.37
Boston	3	16	2.17
Chicago	4	16	3.00@3.25
Chicago	3½	16	2.50@2.75
St. Louis	3½	16	*2.50*
St. Louis	4	16	*3.00*
Seattle	4	16	Off market
Minneapolis	3½	16	2.13
Atlanta	3½	16	2.30
New Orleans	3	16	1.60
New Orleans	3½	16	1.80
New Orleans	4	16	2.00
Dallas	4	18	3.90
Baltimore	3½	16	3.45
Montreal	4	16	4.50
Detroit	3	16	2.84
Detroit	4	16	3.00
Cincinnati	4	16	2.60
Kansas City	4	16	2.15
Philadelphia	3½	16	3.50

CONSTRUCTION MATERIALS

SAND AND GRAVEL—Price for cargo or carload lots to contractor is as follows, per cu.yd.:

	Gravel 1½ In. Current	Gravel 1½ In. One Year Ago	Gravel ¾ In. Current	Gravel ¾ In. One Year Ago	Sand Current	Sand One Year Ago
New York	$1.75	$3.00	$1.75	$3.00	$1.00	$1.50
Denver	2.50	2.00	2.50	1.80	1.10	1.60
Chicago	2.00	2.75	2.00	2.75	2.00	2.75
St. Louis, *per ton*	*0.75*	1.65	1.50	1.70	1.20	1.70
Seattle	1.50	1.50	1.50	1.50	1.50	1.50
Dallas	2.00	1.75	2.00	1.75	2.00	1.75
Minneapolis, *at pit*	1.50	2.00	1.50	....	.50	1.00
Cincinnati, *at pit*	1.00	2.00	1.50	2.00	1.50	1.30
San Francisco	2.25	2.50	2.25	2.50	1.50	1.65
Boston	2.65	2.60	2.65	2.60	2.00	1.60
New Orleans	2.08½	3.60	2.08½	....	1.35	1.85
Los Angeles, per ton	1.35†	1.55	1.35†	....	1.20†	1.30
Atlanta, per ton	1.85	3.00	1.85	....	1.25	1.50
Detroit	2.00	1.85*	2.00	1.85*	2.00	3.50
Baltimore, per ton	1.40	1.40‡	1.60	1.60‡	2.00	.70
Montreal, per ton	1.25	1.50‡	1.50	....	1.25	1.25‡
Birmingham, per ton (Crushed slag used instead of gravel)					*1.25*	1.25‡
Philadelphia	1.50	....	1.57	....	*1.60*	....
Kansas City	2.00	....	2.00	....	1.20	....

* Fine white sand: Pacific, $4 per ton; Ottawa, $4.50

† Freight from quarry to Los Angeles is 70c. per ton, and is included in above price.

‡ Per cu. yd.

CRUSHED STONE—Price for cargo or carload lots f.o.b. city, unless otherwise, is as follows, per cu.yd.:

	1½ In. Current	1½ In. One Year Ago	¾ In. Current	¾ In. One Year Ago
New York	$1.75@1.85	$1.90@2.00	$1.75@1.85	$2.15
Chicago	1.60	2.75	1.60	2.75
St. Louis *delivered*	1.65@2.00*	1.89	1.65@2.00*	1.89
Dallas, *delivered*	2.93	2.25	2.93	2.25
San Francisco	2.25	2.50	2.25	2.50
Boston, *delivered*	3.00*	3.00* (del.)	3.00*	3.00* (del.)
Minneapolis, *at plant*	2.00	2.00	2.25	2.25
Kansas City, *at plant*	*2.10*	2.35	*2.10*	2.35
Denver	3.50		3.50	
Seattle *delivered*	3.00	3.50 (del.)	3.00	3.50 (del.)
Atlanta	2.00*	3.25*	2.00*	
Cincinnati *delivered*	2.37½	2.30	2.08	2.15
Los Angeles	1.60*	1.70*	1.70*	1.80*
Detroit	1.90*	2.00	1.90*	2.00*
Baltimore	1.75*	1.75*	1.65*	1.75*
Montreal	2.00*	2.40*	2.10*	2.60*
Birmingham *delivered*	3.20	....	3.10	....
Philadelphia	1.70*	....	1.55*	....

*Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plants:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.30	$2.00	$1.50
Steubenville District	1.40	1.40	2.00	1.40
Ironton District	1.40	1.40	2.00	1.40
Emporium, Pa.	1.25	1.25	....	1.25
Easton, Catasaqua, Pa.	1.00	1.00	2.00	0.90
Birmingham, Ala.	1.05	1.15	2.05	0.80
Buffalo, N. Y., and Erie, Pa.	1.25	1.25	2.25	1.25
Cleveland, Ohio	1.20	1.20	....	1.00
Eastern Pennsylvania and Northern New Jersey	1.20	1.20	2.50	1.20
Western Pennsylvania	1.25	1.25	2.50	1.25

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	*$16.80*	$12.50	$3.68@3.98	*$3.00@3.18**
Chicago	18.00	....	....	1.40†
St. Louis	22.20	19.00	2.50†	2.50†
Boston	23.00	20.00	3.35†	3.10†
Dallas	25.00	....	....	2.75†
Cincinnati	18.40	16.00	19.00‡	....
San Francisco	22.00	18.00	....	*1.75†*
Minneapolis	29.00	22.00 (white)	1.70†	1.40†
Denver	30.00	....	....	2.95†
Detroit	15.25	13.25	11.50‡	10.50‡
Seattle	27.00	....	*3.00†*	2.75†
Los Angeles	30.00	30.00	....	3.00*
Baltimore	15.00	13.00	....	12.00‡
Montreal	26.00	21.00	15.00‡	11.00‡
Atlanta	19.00	16.00	2.00†	1.50†
New Orleans	....	17.25	....	1.75†
Philadelphia	13.00	11.50	10.50‡	9.50‡

*280-lb. bbl. (net). †Per 180-lb. bbl. (net). ‡Per ton—Refund of 10c. per bbl. Minneapolis quotes brown lime; Kelly Is. white is $1.70, Sheboygan $1.55. Seattle quotes hydrated finishing lime in cloth sacks; paper sacks, $24.00 per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, f.o.b., exclusive of bags:

	Current	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.60	1.60
Atlanta (Magnolia)	11.00 ton	11.00
Cincinnati (Utica)	1.93	2.75
Boston (Rosendale) per bag	.85@.95	2.35

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount for payment within 10 days from date of invoice, not deducted.

	Current	One Month Ago	One Year Ago
New York*	$2.20 to 2.30	$2.30	$3.10
New York, alongside dock to dealers	2.00	2.00	....
Jersey City	2.12	2.12	2.39*
Boston	*2.50*	2.52	3.41
Chicago	1.97	1.97	2.17
Pittsburgh	2.02	2.02	2.17
Cleveland	*2.26*	2.28	2.43
Detroit	*2.17*	2.31	2.51
Indianapolis	*2.21*	2.23	2.31
Toledo	*2.20*	2.31	2.51
Milwaukee	*2.18*	2.19	2.39
Duluth	1.95	1.95	2.10
Peoria	*2.13*	2.14	2.43
Cedar Rapids	*2.26*	2.28	2.51
Davenport	*2.21*	2.22	2.47
St. Louis	2.20	2.20	3.45
San Francisco	2.84	2.84	3.09
New Orleans	3.20	3.20	4.20
Minneapolis	*2.24*	2.26	2.41
Denver	*2.90*	3.10	3.25
Seattle	*2.94*	3.10	3.10
Dallas	*2.40*	2.55	2.85
Atlanta	2.69	2.55	3.00
Cincinnati	*2.35*	2.37	2.57
Los Angeles	3.31	3.31	3.21
Baltimore*	2.50	2.50	2.93
Birmingham	2.27	2.27	....
Kansas City	*2.40*	2.45	2.76
Montreal	3.10	3.10	3.52
Philadelphia	*2.21*	2.23	....

NOTE—Bags 10c. each, 40c. per bbl.:

Current mill-prices per barrel in carload lots, without bags; to contractors:

Buffington, Ind	$1.70
Universal, Pa	1.75
Steelton, Minn	1.75
Fordwick, Va	1.95
Hudson, N. Y	1.90
Lehigh Valley District	1.70
Kingsport, Tenn	1.95
Richard City, Tenn	1.95

*Delivered by truck at site of work.

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh, Mill	Warehouse: New York	Chicago	Dallas	San Francisco
032	22	$0.68	*$1.08*	*$0.76*	$1.15	*$1.15*
049	28	.87	*1.33*	*.98*	1.46	*1.48*
065	35	1.05	*1.58*	*1.18*	1.80	*1.80*
095	45	1.35	*1.99*	*1.52*	2.30	*2.32*
126	57	1.65	*2.43*	*1.87*	2.86	*2.87*
153	68	1.97	*2.88*	*2.23*	3.40	.....
180	78	2.26	*3.28*	*2.56*	3.93	.....
245	103	2.99	*4.29*	*3.38*	5.15	.....
287	119	3.45	*4.95*	*3.90*	5.96	*6.01*
336	138	4.00	*5.72*	*4.52*	7.32	.....
395	160	4.64	*6.61*	*5.20*	8.00	.....

PAVING

036P	17	$0.52	*$0.83*	*$0.58*	$0.88	.....
053P	24	.73	*1.14*	*.82*	1.24	.....
072P	31	.91	*1.40*	*1.00*	1.57	.....
097P	40	1.18	*1.77*	*1.29*	2.02	.....
049P	24	.73	*1.14*	.67	1.24	.....
067P	31	.91	*1.40*	1.00	1.57	.....
084P	40	1.18	*1.77*	1.29	2.02	.....

Made in 16-, 20-, 24-, 28-, 32-, 36-, 40-, 44-, 48-, 52- and 56-in. width in rolls 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted area as follows:

Gage	Weight	*New York	Chicago	St. Louis	San Francisco	Dallas
27 MB	2.3	$21.20	$23.36	*$23.39*	*$23.86*	$25.50
26 MB	2.5	22.65	24.90	.....	*26.21*	27.56
25 MB	3.0	25.30	27.42	27.45	.....	30.71
24 MB	3.4	27.10	29.33	29.33	*27.90*	33.16
22 FO	4.33	31.75	34.06	.....	.....	35.10

* Price to contractors at warehouse or delivered on job in Manhattan, Bronx or Brooklyn.

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	*Pittsburgh Mill	Birmingham Mill	Warehouse, Uncut: New York	Chicago	St. Louis	Dallas	San Francisco
¼ and larger	$1.50	**$1.70**	*$2.53*	*$2.53*	$2.87	$3.50	*$2.75*
⅜ and larger	1.55	1.75	*2.58*	*2.58*	2.92½	3.55	*2.80*
½ and larger	1.60	**1.85**	*2.63*	*2.63*	2.97½	3.60	*2.85*
⅝ and larger	1.75	**1.95**	*2.68*	*2.78*	3.12½	3.75	*3.00*
¾ and larger	2.00	**2.05**	*2.73*	*3.03*	3.37½	4.00	*3.25*

* Pittsburgh mill prices on large tonnages only.

Includes 15c charge for cutting to lengths of 2 ft. and over.

Twisted bars cut to length take extra of 27½c. per 100 lb.

ROLLED FROM RAIL

	Chicago	St. Louis	Dallas		Chicago	St. Louis	Dallas
¼ and larger	*$1.60*	$1.90	$3.25	⅜	*$1.85*	$2.15	$3.50
½ in.	*1.65*	1.95	3.30	¼	*2.10*	2.40	3.75
⅝	*1.70*	2.00	3.35	.....	.....	.....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Current	One Month Ago	One Year Ago	Paving Block: 3-inch*	4-inch*
New York (del.)	**$20.40**	$17.40@18.40	$22.70	$44.50	$49.50
New York (at dock)	14.15	14@15	.....	.....	.....
Chicago	11.00	11.00	15.00	34.00	42.00
St. Louis, salmon	16.00	16.00	15.00	.....	.....
Denver, salmon	14.00	14.00	15.00	.....	.....
Dallas	*11.00*	12.65	25.00	no market	
San Francisco	15.50	15.50	18.00	.....	44.38
Los Angeles	15.50	15.50	14.50	(not used)	
Boston (del.)	17.00	17.00	25.00	46.50	52.60
Minneapolis (del.)	15.00	15.00	24@26	.....	43.00
Kansas City	14.50	14.50	22.00	.....	.....
Seattle	14.00	14.00	19.00	48.00	53.50
Cincinnati	*17.00*	19.00	21@22	41.00	.....
Montreal (del.)	16.00	16.00	20.00	100.00	120.00
Detroit (del.)	**16.50**	**17.00**	15.00	20.00	41.30	44.00
Baltimore (del.)	20.00	20.00	20@25	36.00‡	.....
Atlanta	9.00	9.00	15.00	40.00	.....
New Orleans	*12.50*	14.00	25.50	.....	.....
Birmingham	*10.50*	11.50	.....	.....	.....
Philadelphia	16.00	16.00	.....	.....	42.00

* For paving blocks 3½x8½x3 and 3½x8½x4 respectively. ‡ Vitrified, f.o.b. plant, Baltimore.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Current on Trucks*	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory
4x12x12	$0.11120	$0.2444	$0.0821	*$0.095*	$0.08	*$0.108*	.....
6x12x12	.16670	.3259	.0950	.....	.....	*.156*	.....
8x12x12	.20840	.4345	.1295	*.175*	.145	*.244*	$0.17890
10x12x12	.....	.....	.1584	.....	.....	.....	.21050
12x12x12	.....	.....	.1811	*.255*	*.22*	.....	.27370

* 5 per. off for cash.

	4x12x12	8x12x12	12x12x12
Boston	$0.0960	$0.182	$0.248
Minneapolis (f.o.b. cars)	.0672	.105	.168
Minneapolis (delivered)	.0752	.1175	.188
Cincinnati	.0670	.126	.175
Kansas City	.085	.167	.270
Denver	.08	.145	.21
Seattle	.10	.175	.30
Los Angeles factory	.103	.185	.22
New Orleans	.13	.26	.40
Detroit (delivered)	.070	.135	.225
Montreal	.....	.30	.35
Baltimore	.15	.25	.40
Atlanta	.0675	.13	.....
Dallas	.13	.....	.....
Birmingham	.095	.1785	.....

San Francisco, Philadelphia and New York quote on hollow partition tile.

STRUCTURAL MATERIAL—Following are base prices f. o. b. mill, Pittsburgh and Birmingham together with quotations per 100 lb. from warehouses at places named:

	*Pittsburgh, Mill	Birmingham Mill	New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	1.50	*$1.75*	*$2.63*	$4.00	*$2.97½*	*$2.63*	*$3.10*
Channel, 3 to 15 in.	1.50	*1.75*	*2.63*	4.00	*2.97½*	*2.63*	*3.10*
Angles, 3 to 6 in., ¼ in. thick	1.50	*1.75*	*2.63*	4.00	*2.97½*	*2.63*	*3.10*
Tees, 3 in. and larger	1.50	*1.75*	*2.63*	4.00	*2.97½*	*2.63*	*3.10*
Plates	1.50	*1.75*	*2.63*	4.00	*2.97½*	*2.63*	*3.10*

* Pittsburgh mill price on large tonnages; small tonnages $1.60 per 100 lb.

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh, Mill	Warehouse: New York, Current	New York, One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
¾ in. and larger	*$2.25*	*$3.50*	$5.23	$3.43	$3.77½	*$4.50*	$5.50

CONE HEAD BOILER

½ in. and larger	2.35	3.60	6.00	3.53	3.87½	*4.60*	5.65
⅝ and ¾	2.50	3.76	6.15	3.68	3.87½	*4.75*	5.80
⅞ and 1	2.75	4.00	6.40	4.18	3.87½	*5.00*	6.05

Lengths shorter than 1 in. take an extra of 50c. Lengths between 1 in. and 2 in. take an extra of 25c.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	*$2.50*	$3.25	*$3.90*	$5.00	*$3.48*	$4.95
Cut	2.25	6.10	*5.90*	7.75	4.08	5.00

PREPARED ROOFINGS—Standard grade rubbered surface, complete with nails and cement, costs per square as follows:

	New York: 1-Ply l.c.l.	New York: 2-Ply l.c.l.	New York: 3-Ply l.c.l.	Philadelphia: 1-Ply l.c.l.	Philadelphia: 2-Ply l.c.l.	Philadelphia: 3-Ply l.c.l.
No. 1 grade	$2.08	$2.38	$2.80	$1.92	$2.28	$2.70
No. 2 grade	1.77	2.08	*2.45*	1.67	1.98	2.35

Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $1.90 per roll in carload lots and $2.15 for smaller quantities f.o.b. Philadelphia.

Shingles, red and green slate finish, cost $5.40 per square in carloads; $5.65 in smaller quantities, in Philadelphia.

ROOFING MATERIALS—Prices f.o.b. New York:

Tar felt (14 lb. per square of 100 sq.ft.) per roll of 432 sq.ft.	*$2.00*
Tar pitch (in 400-lb. bbl.), per 100 lb.	1.85
Asphalt roofing (in barrels), per ton, f.o.b. plant*	47.50
Asphalt felt (light), per ton, f.o.b. plant*	*67.00*
Asphalt felt (heavy), per ton, f.o.b. plant*	*68.50*

* Delivered in Metropolitan Dist., $3.00 additional.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.25	$2.87½	$3.38	*$4.10*	$3.28
No. 12	2.30	2.92½	3.43	*4.15*	3.33
No. 14	2.35	3.97½	3.48	*4.20*	3.38
No. 16	*2.55*	3.07½	3.58	*4.30*	3.48
Black					
*Nos. 18 and 20	2.85	3.95	3.95	*5.40*	3.80
*Nos. 22 and 24	2.90	4.00	4.00	*5.45*	3.85
*No. 26	2.95	4.05	4.05	*5.50*	3.90
*No. 28	3.00	4.15	4.15	*5.60*	4.00
Galvanized					
No. 10	3.00	4.15	4.15	....	4.00
No. 12	3.10	4.25	4.25	*5.55*	4.10
No. 14	3.10	4.25	4.25	*5.55*	4.10
Nos. 17 to 21	3.40	4.55	4.55	*5.85*	4.40
Nos. 22 and 24	3.55	4.70	4.70	*6.00*	4.55
*Nos. 25 and 26	3.70	4.85	4.85	*6.15*	4.70
*No. 28	4.00	5.15	5.15	*6.45*	5.00

*For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages: for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Current	New York: One Year Ago	Chicago: Current	Chicago: One Year Ago
Raw in barrel (5 bbl. lots)	**$0.77**	$0.80	**$0.80**	**$0.91**

WHITE AND RED LEAD—Base price in cents per pound:

	Red — Current		Red — 1 Year Ago		White — Current	White — Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry or In Oil	Dry or In Oil
100-lb. keg	12 25	13 75	13 00	14 50	12 25	13 00
25 and 50-lb. kegs	12 50	14 00	13 25	14 75	12 50	13 25
12½-lb. keg	12 75	14 25	13 50	15 00	12 75	13 50
5-lb. cans	15 25	16 75	16 00	17 50	15 25	16 00
1-lb. cans	17 25	18 75	18 00	19 50	17 25	18 00

LUMBER

Prices wholesale to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in more than carload lots:

Lumber Prices to Contractors in Yards at San Francisco

	6 8 and 12 Ft.	10 16 18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$28 00	$31 00	$34 00	$36 00
3x6 and 8	28 00	31 00	32 00	34 00
4x4-6 and 8	30 00	33 00	34 00	36 00
3x10 and 12	30 00	32 00	34 00	36 00
3x14	31 00	33 00	35 00	37 00
4x10 and 12	32 00	34 00	36 00	38 00
4x14	33 00	35 00	37 00	39 00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft
6x10	$33 00	$35 00	$37 00
6x14	35 00	37 00	39 00
8x10	33 00	35 00	37 00
3x14	35 00	37 00	39 00

New York, Chicago, St. Louis and Detroit—Wholesale prices to dealers of long leaf yellow pine.

	New York* 20 Ft. and Under	New York* 22–24 Ft.	Chicago 20 Ft. and Under	Chicago 22-24 Ft.
3x 4 to 8x8	$38 00	$39 00	**$40 00**	**$42 00**
3x10 to 10x10	41 00	42 00	**42 00**	**44 00**
3x12 to 12x12	44 00	45 00	**44 00**	**46 00**
3x14 to 14x14	47 50	48 50	**48 00**	**50 00**
3x16 to 16x16	52 50	53 50	**53 00**	**55 00**
3x18 to 18x18	60 00	61 00	**59 00**	**61 00**
4x20 to 20x20	70 00	71 00	**66 00**	**68 00**

* Wholesale price to dealers; to contractors, on lighters or cars, about $5 additional. Short leaf pine up to 14 x 14 costs $15 per M. less.

St. Louis: Yellow pine, 10@20 ft. long, 3 x 4 to 6 x 6, $20 00; 3 x 8 to 8 x 8, $19; 3 x 12 to 5 x 12, $25; 3 x 14 to 5 x 14, $28; 3 x 16 to 4 x 16, $32; 12 x 14 to 14 x 14, $27.

Detroit—Norway pine 2 in. x 4 in., 10 ft. x 16 ft. long, $35, 2 in. x 12 in., 10 ft. x 16 ft. long, $37; short leaf yellow pine 2 in. x 4 in, 9 ft. x 12 ft. long, $27.50 2 in. x 8 in., 18 ft. x 20 ft. long, $31; yellow pine flooring No. 1 common 1 in. x 3 in., $39.75, 1 in. x 4 in., 6 ft. x 12 ft. long, $37.25; yellow pine shiplap $37.00.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12 x 12 and under, for sizes over 12 x 12 add $2 for merchantable add $2 to sizes 10 x 10 and under. For pine add $2 to the price of merchantable for all sizes.

Other Cities

	8 x 8-In. x 20 Ft. and Under — P.	Fir	Hemlock	Spruce	12 x 12-In. 20 Ft. and Under — P.	Fir
Boston	$50 00	$52 00	$55 00	$45 00	$54 00	$52 00
Seattle		**19 00**				**20 00**
New Orleans	28 00				25 00	
Baltimore	36 50				38 50	
Cincinnati	42 00	50 00			46 00	64 00
Montreal	78 00	85 00	68 00	78 00	78 00	100 00
Los Angeles		*41 00*	*50 00*			*41 00*
Denver		*33 25*	*34 25*	**33 75**		*34 25*
Minneapolis	40 00	40 00	37 00		47 00	38 00
Atlanta	*29 00*				*35 00*	
Dallas	33 00				34 **00**	
Kansas City	33 00	**34 00**			*36 00*	**35 00**
Birmingham	20 00				26 00	
Philadelphia	32 00	*35.00*	*39.00*	*42.00*	*38.00*	*35 00*

	1-In. Rough, 10 In. x 16 Ft. and Under — P.	Fir	Hemlock	2-In. T. and Gr. 10 In. x 16 Ft. — P.	Fir
Boston	$47 00	$48 00	$32 00	$45 00	$48 00
Seattle		**15 00**			**16 50**
New Orleans, at mill	65 00			32 00	19 50
Baltimore	35 00			36 50	
Cincinnati	62 50	80 00		33 50	
Montreal	120 00	60 00	60 00	80 00	80 00
Los Angeles		*34 00*	*33 00*		63 00
Denver		*29 25*	29 25		**30 25**
Minneapolis	38 50	**36 25**	33.25	36 00	**34 75**
Atlanta	*17 00*			*20 00*	
Dallas	32 00	30 00		36 00	
Kansas City	*35.00*	**34 50**		*20 00*	31 00
Birmingham	18 00			18 00	
Philadelphia	*30 00*	*35 50*	**37 00**	*28.00*	*26.00*

Montreal—Up to 32 ft.; over which, $3.00 per M. increase up to 30 ft.

Birmingham—Quotes carload lots, f.o.b. sidings. $2 additional per M. ft. for delivery.

Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.

Denver—Quotes dealers prices to contractor on large projects.

FREIGHT RATES

On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Baltimore	$0 33½	Detroit	$0 32½
Birmingham	76½	Kansas City	81½
Boston	40½	New Orleans	51½
Buffalo	29½	New York	38
Chicago	38	Pacific Coast (all rail)	1 66½†
Cincinnati	325	Philadelphia	35
Cleveland	24	St. Louis	47½
Denver	1 35*	St. Paul	66½

* Minimum carload, 40,000 lb.

†Minimum carload, 50,000 lb., structural steel only; 80,000 lb. for other iron or steel products.

CONTRACTORS' SUPPLIES

STEEL SHEETPILING—The following price is base per 100 lb. f. o. b. [illegible] burgh, with a comparison of a month and a year ago:

Current	One Month Ago	One Year Ago
$1 75@1 80	$1 80	$3 00

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East Missouri River
Hercules red strand, all constructions	30%
Patent flattened strand, special and cast steel	30%
Patent flattened strand, iron rope	15%
Plow steel round strand rope	45%
Special steel round strand rope	40%
Cast steel round strand rope	32½%
Round strand iron and iron tiller	15%
Galvanized steel rigging and guy rope	17½%
Galvanized iron rigging and guy rope	+2½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¼-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8 ft., ⅜-in., 6; ½-in., 4½; ⅝-in., 3½; ¾-in., 2 ft. 10 in.; 1-in., 2 ft. 4 in. Following is price per pound for ¼-in. and larger, in 1200-ft. coils:

Boston	$0 20	New Orleans	$0 17½
New York	18½	Los Angeles	16½
Chicago	18	Seattle	*16*
Minneapolis	19½	St. Louis	**19**
San Francisco	**17**	Montreal	30
Atlanta	21	Detroit	**19**
Denver	**20**	Baltimore	20
Cincinnati	**20**	Kansas City	**18½**
Dallas	29	Birmingham	20½
Philadelphia	17½		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0 3075	$0 3425
Boston	.24	.275
Kansas City	.24½	.28
Seattle	.1875	.2125
Chicago	.2275	.2525
Minneapolis	.2274	.2530
St. Louis	**.26**	**.295**
Denver	.2350	.2700
Dallas	.29	.375
Los Angeles	.25	.29
Atlanta	.2675	.3025
Baltimore	.2550	.27
Cincinnati	**.2475**	.2725
Montreal	.22	.26
Birmingham, *delivered*	.165	.205
New Orleans	.2725	.3075
San Francisco	.195	.23
Philadelphia	.2525	.2875

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0 14	$0 19
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	0 18½	0 25
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	0 21	0 27½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	0 24	0 32½
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	0 26	0 34½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	0 33	0 42

SCRAP—The prices following are per gross ton paid to dealers and producers in New York. In Chicago and St. Louis the quotations are per net ton and cover delivery at the buyer's works, including freight transfer charges.

	New York	Chicago	St. Louis
No. 1 railroad wrought	$10 50	$11 50	$13 50
Stove plate	10 50	12 00	13 50
No. 1 machinery cast	16 50	13 50	16 00
Machine shop turnings	**4 00@5 00**	4 00	6 50
Cast borings	**7 50@8 00**	5 50	8 50
Railroad malleable cast	*8 50*	12 50	11 00
Re-rolling rails	*9 50@10 00*	13 00	12 00
Relaying rails	*27@28*	30 00	27 00

SHIP SPIKES—Current prices per 100 lb.:

In	San Francisco — Galv.	San Francisco — Black	Seattle Black
½	$9 10	$7 40	$8 55
⅝	8 65	6 65	8 25
¾	8 50	6 50	8 10

Pittsburgh base in lots of 200 kegs or more $2.25@2.30.